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ABSTRACT

This report presents materials from a study to survey and identify the electronic technician needs of industry and to relate those needs to curriculum development in community colleges. Chapters 1 and 2 are an introduction and review of the study, "Curriculum Requirements for Electronic Technician Training." Chapter 3 discusses four community college electronic technology programs: Olympic College, Washington; Foothill College, California; College of San Mateo, California; and Utah Technical College. Curricula and some course descriptions are provided. Chapter 4 describes positions, job descriptions, and/or training programs at seven electronic industries that were visited. Results from a survey of the electronic technical needs of industry are provided in chapter 5 through 12 figures (charts). Chapter 6 displays results of the latter part of the survey that was designed to identify curricular (course) needs for the electronics technician. Chapter 7 then gives a recommended procedure for design of a two-year electronics curriculum. A sample general two-year electronics curriculum, based on survey results, is recommended as a model that may be added to or deleted from as appropriate. Course descriptions list topics to be covered. Appendixes include the study reviewed in chapter 2 and the survey instrument. (YLB)

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FINAL REPORT

ELECTRONIC CURRICULUM REVISION

Project No. 81-AKX(188)NN

Darrell A. Estep
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16th and Chester
Bremerton, WA 98310

August 31, 1981

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FINAL REPORT

Project No. 81-AKX (188) NN

Electronic Curriculum Revision

Research Project in Vocational Education
Conducted Under
Public Law 94-482

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CHAPTER I

INTRODUCTION

Sweeping changes are taking place in the electronic industry at an ever-accelerating pace. These changes have been brought about by new developments in science and technology. The impact of this rapid scientific and technological progress upon the institutions which must train industry's electronic technicians has been twofold. Both the quantity and the quality of the electronic personnel needed are changing, and the educational establishment has not kept up with these changing requirements.

The nature of the changes taking place in industry is such that the quantity of needed electronic technicians is increasing rapidly. Many traditional skills and jobs are becoming obsolete, and in their place, new jobs are being created, requiring technically competent personnel. The devices and processes in industry are being continually updated or completely replaced by more complex instrumentation that is microprocessor controlled and more sophisticated techniques which demand a greater degree of technical competence and often new technical skills.

PURPOSE

The objective of this study was to survey and identify the electronic technician needs of industry and to relate those needs to curriculum development in community colleges. An attempt was made to determine the specific types of technicians and the talents which they should possess.

METHODOLOGY

To accomplish the objective above, a review of the literature was made. Most of the literature was outdated with the exception of "Curriculum Requirements for Electronic Technician Training," published by the American Electronic Association in November, 1980. Catalogs from fifteen electronic programs judged to be among the top programs in the country were studied. Personal visits were made to Foothill College and College of San Mateo. Their programs are included in the study. Several electronic industries in the Puget Sound and San Jose areas were visited. Working with the advisory committee, a questionnaire survey was devised and sent to over sixty electronic industries to obtain information about the technological needs of the companies relating to electronic technicians.

CHAPTER II

REVIEW OF LITERATURE

Much of the research in electronic curriculum is outdated and is excluded in this review. This chapter will summarize a study entitled "Curriculum Requirements for Electronic Technician Training" prepared by the AEA Curriculum Task Force in cooperation with the Industrial Relations Committee. Background and AEA Curriculum Task Force recommendations are included in this chapter. The entire study is included in the appendix.

Background

In March, 1980, a group of community college presidents and superintendents, electronics company presidents, members of the AEA San Francisco Council's Executive Committee and AEA Training Consortium met to address ways to remedy the shortages of technical people available for employment. At their direction, an AEA Curriculum Task Force was appointed with ten industry members. This Task Force was to identify content in four basic or "core" electronic technician courses--AC, DC, Digital and Semiconductor--which reflects a state-of-the-art, industry-wide perspective.

Rick Moon of Rolm Corporation developed a "straw man" curriculum and members of the AEA Curriculum Task Force refined it over the next four months. In August, electronics faculty from Santa Clara Valley colleges were invited to give input, eventually forming a six-person industry-education group.

Further material refinement occurred for another two months. Value and depth of emphasis scales for content topics in all four courses were developed, and objectives were written for the AC and DC courses.

A five-member subcommittee of AEA's National Industrial Relations Committee (IR) was appointed to review the final materials. They commended highly the efforts of the AEA Curriculum Task Force and recommended IR Committee endorsement with the understanding that the depth scale ratings--which reflect the degree of emphasis industry wishes education to place on a given topic--be reviewed by companies in given locales and, where necessary, adjusted to meet local industry needs. The flexibility provided by adjusting the depth scale ratings make the materials useful to companies and schools in all states.

The AEA IR Committee endorsed the materials in November, 1980.[1]

AEA CURRICULUM TASK FORCE RECOMMENDATIONS

Because colleges lack equipment and are often three to five years behind state-of-the-art technology, courses should provide basics, with companies providing specifics for new employees.

Every two-year electronic technician program should include a "transition" course to employment, where students apply classroom theory to practical simulations, as defined by industry.

Curriculum should be "competency-based " focused on practical outcomes so that students are helped by instructors to convert fundamental concepts into practical applications.

[1]American Electronic Association, "Curriculum Requirements for Electronic Technician Training," Palo Alto, California, 1980, p. iv.

Ideally, students should be tested to ensure basic math skills through algebra before enrolling in a DC course. Present practice, however, is to allow students to simultaneously take a beginning math course and a DC course. This is done because 50-75% of the students lack basic math through algebra competency. To require a "make-up" math course one semester and thus force students to wait for a beginning electronics course the second semester is counter-productive; students will turn towards social science and liberal arts where they will not have to spend time in remediation courses.

Given the poor math foundations of beginning students, therefore, the following options are strongly suggested:

(1) Math should be integrated with electronics instruction in a synchronized, lockstep approach and taught as "Electronics Math" within the electronics department rather than the present abstract-theoretical.

(2) Math should be integrated with electronics within the same source and taught by the same teacher. This option faces opposition from the math departments and credentialing requirements which generally require a Masters Degree in math--something few electronics instructors have.

The best way to keep the curriculum up-to-date with industry's needs is for AEA to develop tests which students can take and be "certified," a future option to be discussed by the Association.[2]

[2] Ibid., p. vii

CHAPTER III

COMMUNITY COLLEGE ELECTRONIC PROGRAMS

Mr. Gordon Rockmaker, the Editor-in Chief, Electricity/ Electronics of the McGraw-Hill Book Company, was contacted and requested to send a list of the top electronic technology programs around the country. His letter is included in the appendix. This is the list he sent:

Foothill College, California
College of San Mateo, California
Queensborough Community College, N.Y.C.
Wentworth Institute, Boston
Ohio Institute of Technology, Columbus
Utah Technical College, Provo
Milwaukee Area Technical College
Macomb County C. C., Warren, Mich.
Franklin Institute of Boston
Louisiana Vocational & Technical Institute, Shreveport
Catawba Valley Technical Institute, Hickory, N. C.
New York Institute of Technology
Tampa Technical Institute, Florida
Florissant Valley C. C., Ferguson, Missouri
Portland Community College, Oregon

Catalogs were obtained from as many of the above mentioned schools as possible. Personal visits were made to Foothill College, and College of San Mateo. Their programs are discussed in this chapter, along with Utah Technical College at Provo, and the present electronic program here at Olympic College.

OLYMPIC COLLEGE ELECTRONICS

At the present time, electronic students are required to take a basic first-year program and then choose one of three tracks: Electronic Industrial Technician, Electronic Communication Specialist or Electronics General.

These are the curricula:

FIRST YEAR CURRICULUM

Required for all Electronic Students

1st Quarter	2nd Quarter	3rd Quarter
Direct Current	Alternating Current	Intro to Solid State
DC Lab	AC Lab	Solid State Lab
Orientation to Ind.	Network Theorems	Intro to Dig. Logic
Math	Math	Math

SECOND YEAR CURRICULA

Electronics Industrial Technician

1st Quarter	2nd Quarter	3rd Quarter
Solid State Devices	Adv. Solid State Devices	Spc Circuits
Printed Circuits	Lab	Spc Cir Lab
Elex Drawing	Micro-computers	Elex Project
Adv. Digital	English 101	Elex Project Lab
		Tech Writing

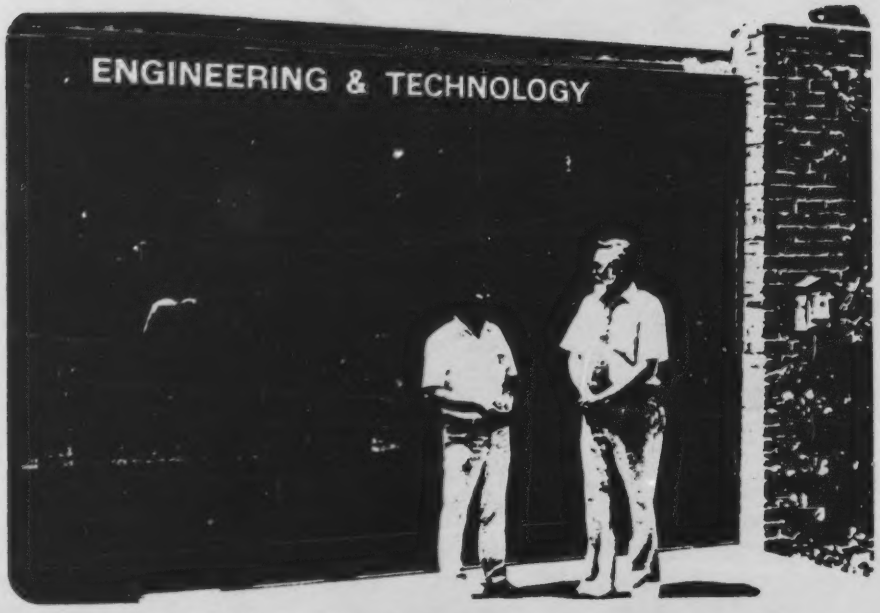
or **Electronics Communications Specialities**

Solid State Devices	Adv. Solid State Devices	Spc Circuits
Printed Circuits	Lab	Spc Cir Lab
Comm Rcvrs	2nd Class License	Elex Project
Adv Digital	Antennas	Elex Project Lab
	English 101	Tech Writing

or **Electronic General**

Solid State Devices	Adv. Solid State Devices	Spc Circuits
Printed Circuits	Lab	Spc Cir Lab
Elex Drawing	Elective	Elective
Elective		

FOOTHILL COLLEGE



The Foothill College main campus is located on 122 acres in the rolling foothills of Los Altos Hills. It is a beautiful campus. The buildings are a blending of old brick, redwood, massive concrete piers and chipped shake roofs. Special features of the campus include the electronic museum, a planetarium and an observatory.

The engineering and technology division offer three distinct programs in electronics - electronics, semiconductor processing and computer service technology.

FOOTHILL ELECTRONIC TECHNICIAN PROGRAM

Since the electronics program began at Foothill College in 1958, it has consistently supplied the Bay Area electronics industry with immediately, highly trained technicians. Traditionally, Foothill graduates have enjoyed both rapid promotion and virtually one hundred percent employment through both business boom and bust.

Typically, a Foothill Electronics student earns an A.S. degree in two years. He may choose to follow a General Electronics option or he may specialize in one of the following during his second year: Digital, Microwave, Solid State Circuits or Television.

FOOTHILL COLLEGE ELECTRONICS MAJOR

First Year Curricula

Fall Quarter	Winter Quarter	Spring Quarter
DC Circuits	AC Circuits	Active Dev & Cir
Elex Math	Elex Math	Computer Appl.
Engr Prof.		

Second Year Curricula

Elex Elective	Elex Elective	Elex Elective

Note: 20 units of electronics must be completed at Foothill. (Electronics 60, 101, 102, 308, 309, 310, and 311 are not acceptable as part of the required 20 units)

SECOND YEAR ELECTIVES

DIGITAL OPTION		UNITS
Fall	Elex. 58 (Digital Electronics)	5
Winter	Elex. 59 (Applications of Digital Electronics)	5
Spring	Elex. 70 (Introduction to Microprocessors)	5
LINEAR OPTION		
Fall	Elex. 58 (Digital Electronics)	5
Winter	Elex. 62 (Integrated Circuits)	3
	Elex. 62L (Linear Integrated Circuits Lab)	1
Spring	Elex. 65 (Communications Circuits)	5
MICROWAVE OPTION		
Fall	Elex. 80 (Intro to Microwave Electronics)	4
Winter	Elex. 81 (Microwave Theory & Measurements)	5
Spring	Elex. 82 (Microwave Theory & Measurements)	5

GENERAL OPTION			UNITS
Fall	Elex 58	(Digital Electronics)	5
		Plus two more Electronic Electives (Electronics 60, 101, 102, 308, 309, 310 and 311 are not acceptable electives)	

FOOTHILL COLLEGE
Engineering/Technology Division Fall 1979

1. Catalog Description

Electronics 51 FUNDAMENTALS OF D. C. CIRCUITS 7 Units

Prerequisite: Mathematics 71 (may be taken concurrently)

Six hours lecture, four hours lab.

The nature of matter, DC theory and circuits, meters, units, and measurements; resistance, inductance, and capacitance; voltage and current sources, energy transfer circuit analysis and simulation of circuits. Magnetic and electric fields, energy storage, and time constants. Mathematical models. Introduction to meters, units, and measurements. Laboratory experiments and techniques.

2. Required Background of Experience

Lecture:

The student will be expected to be able to interpret and apply the basic concepts of physics and electricity to the special field of electronics. He will be expected to develop an understanding of, and a sound background in, the basic concepts of electricity and magnetism and of the principles of electronic circuits. It is expected that the student will become proficient in the use of the calculator as used in elementary electronics and that he will develop the background necessary to prepare him for Electronics 52 and for employment as an electronics technician.

Laboratory:

The student will be able to make a reliable electrical connection and will learn how to check its conductivity. Experiments will aid in the further understanding of the theory being taught in the lecture. The practical aspects of electricity, such as instrument, component, and human error, and the methods of circumventing or compensating for many of them, will be learned. The student will learn to appreciate the dangers of electrical apparatus and know what is necessary to prevent accidents. The student will learn how to write and to be able to prepare a formal technical report on each experiment. The student will also learn how to keep a standard laboratory notebook.

4. Minimum Student Materials

Pencil, straight edge, 8 1/2 x 11 paper, calculator with original functions, hand tools, soldering pencil, test leads, etc. (approximate cost: $20)

See above; one set of test leads to be made by student in lab; one tool box containing a knife, diagonal pliers, long nose pliers, screw driver, soldering iron, solder, etc.

5. Minimum College Facilities

Classroom and electronics laboratory.

6. Expanded Description of Content and Method

LECTURE:

A. Content
   1. Introduction
      a. Atomic structure of matter
      b. Free electron theory
      c. Charge carriers
   2. Basic Concepts of Electricity
      a. Units used to measure voltage, current, and charge
      b. Batteries used as a voltage source
      c. Conductors and insulators
      d. Resistance and conductance
         1) Effect of length, cross-sectional area, temperature, and atomic structure on resistance
         2) Color coding and types of resistors
   3. DC Circuit Theory
      a. Series and parallel circuits
         1) Voltage, current, resistance, and power calculations in series and aprallel circuits
         2) Kirchhoff's current and voltage laws
      b. Series parallel resistive networks and network analysis
         1) Solution of network problems usisng various network theorems
         2) Instrument loading
         3) Thevenins Norton's and Millmans' theorems
         4) Mesh and Node Equations
         5) Superposition theorem
      c. Transient Analysis
         1) Capacitors
         2) Magnetic Circuits
         3) Inductors
         4) Time Constants
      d. DC Instruments
      e. Introduction to Alternating Current

B. Method of Evaluating Outcome

Quizzes, midterm exam(s), laboratory reports and a final examination will be used to evaluate student performance.

7. Texts and References

Leach, D.P., Basic Electric Circuits, Latest edition, John Wiley,

Long W., and Malvino A., Electric Circuits Laboratory Manual, Krieger Publishing Co.

FOOTHILL COLLEGE

Engineering/Technology Division

1. Catalog Description — Fall 1979

Electronics 52 FUNDAMENTALS OF A. C. CIRCUITS — 7 Units

Prerequisites: Electronics 51; Mathematics 72 (may be taken concurrently).

Six hours lecture, four hours lab.

AC theory, instruments, units, and measurements. Inductive and capacitive reactance, phase relationships, rectangular and polar coordinate systems of notation, AC sources, transformers, energy distribution and transfer, resonant circuits, and tuning. AF and RF signals, non-sinusoidal waveforms, DC and AC equivalent circuits. Introduction to the diode and its application as a rectifier in AC power supplies.

2. Required Background of Experience

None beyond the prerequisites.

3. Expected Outcomes

The student will be able to interpret and apply the relations of physics and science to the special area of electronics. He develops a logical approach to problem solving and reasoning in the scientific method. He is developing a background of knowledge and skills to prepare himself for Electronics 53 and employment.

4. Minimum Student Materials

Protractor, scale, straight edge, pencil, slide rule (Log-log Duplex Decitrig).

5. Minimum College Facilities

Classroom and electronics laboratory.

6. Expanded Description of Content and Method

Daily reading assignments, study exercises, and problems pertinent to subject are assigned. Problems are graded, discussed and returned to student. The student is encouraged to expand his sources by using the library, current periodicals, handbooks and commercial materials. Stress is placed on critical analysis and problem solving appropriate to subject matter.

A. Review of Time Constants in L and C Circuits.

B. AC Current and Voltage, Reactances, Phase Relations, Power Relations.

C. Complex Numbers and Phasors
   1) Introduction of rectangular and polar representation of phasors

6. Expanded Description of Content and Method (cont'd)

2) Conversion between forms
3) Mathematical operations using complex numbers

D. Series, Parallel and Series-Parallel AC Circuits

E. Use of Circuit Theorems in Analysis of AC Circuits

F. True, Apparent and Reactive Power in AC Circuits

G. Resonance

1) Series and parallel resonance
2) Z, I, and Q in resonant circuits
3) Selectivity of resonant circuits

H. Use of Impedance Bridges, DC Voltmeters, and Oscilloscopes

I. Transformers

J. Review of Atomic Structure of Matter

K. Introduction to Semiconductor and Vacuum Tube Diodes

L. Rectifiers and Power Supplies

7. Methods of Evaluating Outcomes

Quizzes, midterm exam(s), laboratory reports and final examination.

8. Texts and References

Leach, Donald, Basic Electric Circuits, latest edition, John Wiley and Sons.

Long, William & Malvino, A.P., Electric Circuits Laboratory Manual, John Wiley and Sons.

FOOTHILL COLLEGE

Engineering/Technology Division

COURSE OUTLINE

1. Catalog Description — Fall 1979

Electronics 53 ACTIVE DEVICES AND CIRCUITS 7 Units

Prerequisites: Electronics 52 or 52N.

Six hours lecture, four hours lab. Fall 1979

Semiconductor diodes and development of simple diode models. Large and small signal diode circuits. Introduction to the transistor and the vacuum tube, and development of suitable equivalent circuits. Analysis of electronic circuits including bias circuits, small signal amplifiers, negative feedback, multistage amplifiers, tuned amplifiers, D-C amplifiers, power amplifiers, and amplifier frequency response. Troubleshooting techniques emphasized.

2. Required Background of Experience

No background is required beyond meeting course prerequisites and being a student in good standing at Foothill College.

3. Expected Outcomes

The student will be able to analyze and explain the theory of operation of basic power supplies, bipolar and Field Effect transistors, single stage and multistage amplifiers in CE, CB and CC configurations. He will understand, recognize and be able to explain the characteristics of circuits employing positive and negative feedback in both small signal and large signal amplifiers. The student will be able to use voltmeters, signal sources and the oscilloscope in analyzing power supply and amplifier performance and in locating circuit faults. The student will be able to understand and use manufacturers literature and service notes, follow operating instructions and testing procedures of electronic equipment, and correctly specify and replace defective components.

In Electronics 53 the student develops a background of knowledge that prepares him for entry into specialized courses in microwave, digital, or linear electronics. At the completion of Electronics 53 the student's informational background and skill level will be typical of a beginning Junior Electronics Technician in industry.

4. Minimum Student Materials

Textbook and writing materials, with an electronic calculator recommended.

5. Minimum College Facilities

Adequately lighted classroom equipped with blackboard, chalk, erasers, and power outlets. Reference materials and demonstration equipment should be conveniently available.

6. Expanded Description of Content and Method

This outline covers the course content of Electronics 53. The sequence of topics many be adjusted as deemed desirable to improve presentation and enhance learning.

1. Diodes, rectification, and power supplies.
   a) Diode characteristics, diode types.
   b) Rectification and filtering; practical power supplies and circuits; the "Thevenin" equivalent and analysis of malfunctions.
   c) Zener diodes, shunt regulation.

2. Bipolar Transistors.
   a) NPN and PNP, required bias of base-emitter junctions and of base-collector junctions; essential static conditions in typical operation.
   b) Basic configurations: CE, CB and CC; impedance and gain characteristics of each configuration.
   c) Loading resistors: Static (D-C) and dynamic (AC, signal conditions) values of loads.
   d) Load lines, operating points and distortion.
   e) Small signal amplifiers, multistage amplifiers, bandwidth and frequency limitations, limiting factors.
   f) Power amplifiers, class A and class B; problems that occur with high power and poor efficiency.
   g) Feedback and its effect on gain, distortion, impedance and bandwidth; applications of positive and negative feedback.

3. Field-effect devices: Field-effect transistors and vacuum tubes.
   a) Basic junction field-effect transistors (JFETs), required bias and static conditions. V-I characteristics and families of curves.
   b) Basic configurations, CS, CG and CD; characteristics compared with similar characteristics of bipolar transistors.
   c) Loading, operating points, distortion; small signal amplifiers using FETs compared to amplifiers using bipolar transistors.
   d) Vacuum tube amplifiers, similarities to FET amplifiers; characteristics shared by all amplifiers regardless of device used, gain, loading, classes of operation, feedback, essential static conditions required to assure proper dynamic operation.
   e) MOSFET's

4. Miscellaneous Topics and Devices.
   a) Series voltage regulation using active devices (the folloiwng to be covered as time permits.)
   b) Modulation and mixing; the role of non-linearity (distortion) in both processes.
   c) SCR's TRIAC's, UJT's, tunnel diodes and other devices.

Methods of Evaluating Outcomes

Evaluation of student performance will be through assessment of the quality of completed work assignments, tests and examinations. Evaluation of laboratory work that is a part of this course should include both quality of completed work and student work habits. Repeated tardiness, and/or excessive absence without good cause, failure to meet deadlines and other factors typically used in on-the-job evaluation of technicians should be considered as realistically as possible and every effort made to encourage the development of good work habits.

8. Texts and References

Malvino A. P., Electronic Principles, McGraw-Hill, latest edition.

Malvino et. al., Electronic Principles (Lab Manual), McGraw-Hill, latest edition.

FOOTHILL COLLEGE

Engineering/Technology Division

1. Catalog Description — Winter 1977

Electronics 58 — DIGITAL ELECTRONICS — 5 Units

Prerequisite: Electronics 53 or Electronics 53B.

Four hours lecture, three hours laboratory.

Digital principles, including number systems, logic gates, practical circuits, and integrated circuits. Application to basic digital building blocks such as clocks, shift registers, counters, etc. Emphasis will be on practicality, construction of basic digital blocks using commercially available integrated circuits, and the analysis and testing of these basic systems.

2. Required Background of Experience

None beyond the prerequisite.

3. Expected Outcomes

An understanding of digital principles and techniques common to any digital system. Sufficient understanding will be developed to permit the student to continue his studies in digital electronics. He should be able to discuss and understand all of the concepts and to relate the to commercial applications. He is expected to develop the ability to work independent of close supervision.

4. Minimum College Materials

Text, notebook, paper, pencils.

5. Minimum College Facilities

Classroom with electronics laboratory.

6. Expanded Description of Content and Method

A. Review of diodes, CE transistor operating at saturation, cutoff. Review of transient RC, RL_2 switching circuits.

B. 1) Detailed analysis of T^2L and CMOS imput/output characteristics, timing.
   2.) Manufacturer's specification sheets.

C. Digital codes.

D. Binary, octal, hexidecimal numbers and arithmetic.

E. Logic circuits
   1) Truth tables
   2) Logic diagrams
   3) Boolean Algebra
   4) Karnaugh Mapping

F. Multivibrators

C Counters and registers.

7. Methods of Evaluating Oucomes

Regular quiz material, midterms, class reports, special project evaluation, and final exams will be weighed to determine outcome in terms of expected outcomes.

8. Texts and References

Malvino, A. and Leach, D., Digital Principles and Applications, 1st ed., McGraw-Hill.

Leach, D.P., Experiments & Digital Principles, latest ed., McGraw-Hill.

FOOTHILL COLLEGE

Engineering/Technology Division

1. Catalog Description — Spring 1976

Electronics 59 APPLICATIONS OF DIGITAL ELECTRONICS 5 Units

Prerequisites: Electronics 58 or equivalent.

Four hours lecture, three hours laboratory.

Basic operation of digital equipment, including logic organization, block diagram analysis, and hands-on experience. Application of digital equipment to real time systems.

2. Required Background or Experience

Electronics 58 or equivalent.

3. Expected Outcomes

The student will learn to integrate, verify the proper operation of, and repair selected digital subsystems. Correct use and interpretation of the multitrace oscilloscope and commonly available logic probes will be emphasized.

The student will learn techniques in interfacing different logic families together, and interfacing logic families to common I/O devices.

4. Minimum Student Materials

Text, notebook, paper, pencils, electronics laboratory hand tools.

5. Minimum College Facilities

Classroom and electronics laboratory.

6. Expanded Description of Content and Method

A. Review of TTL and CMOS input/output characteristics. Interfacing these logic families together, and to common I/O devices such as switches, LED displays, etc.

B. Counters and Registers: Ripple, feedback, series, parallel, ring, shift, BCD, shift registers and latches.

1. SSI design, construction and test
2. MSI analysis and use
3. Decoding
4. Timing considerations
5. Presetting, resetting

C. D/A and A/D conversion.

1. Resolution, accuracy and linearity

2. R-2R ladders: Descrete and integrated
3. Linear comparators
4. D/A and A/D subsystems

D. I/O Devices

1. Multiplexing
2. Encoding/decoding matricies
3. Punched tape, cards
4. Magnetic tape

E. Memories

1. Semiconductor RAM, ROM and PROM
2. Magnetic core

F. Student Project: The student will integrate and make operational a project selected by the instructor which incorporated several subsystems from topics A, B, C, D and E above.

7. Methods of Evaluating Outcomes

Regular quiz material, midterms, class reports, laboratory reports, special project evaluation, and final exams will be weighed to determine outcome in terms of expected outcomes.

8. Texts and References

Malvino, A. and Leach, Donald, Digital Principles and Applications, McGraw-Hill Book Company.

FOOTHILL COLLEGE

Engineering/Technology Division

1 Catalog Description Spring 1977

Electronics 62 LINEAR INTEGRATED CIRCUITS 3 Units

Prerequisites: Electronics 53 or Electronics 53B or equivalent.

Three hours lecture.

A study of the design processes and techniques used in the manufacture of linear integrated circuits, which will provide an understanding of their functional operations and limitations. The application of currently available commercial integrated circuits to provide solutions to a number of electronic network problems.

2. Required Background of Experience

A working knowledge of the theoretical and practical electronics background expected at the completion of Electronics 53 or Electronics 53N.

3. Expected Outcomes

The student will:

a. gain an understanding of the processes and techniques involved in the manufacture of linear integrated circuits.
b. become familiar with the common methods used in the design of linear integrated circuits.
c. study the functional operation and limitations of currently available linear integrated circuit modules including the interpretation of circuit characteristics from manufacturers' data sheets.
d. study the applications of integrated circuits in a wide variety of electronic networks.

4. Minimum Student Materials

Text, notebook, paper, pencils.

5. Minimum College Facilities

Classroom.

6. Expanded Description of Content and Method

a. Integrated circuit (I.C.) processes
b. Passive I.C. components
c. Active I.C. components
d. I.C. design techniques
e. Feedback
f. I.C. amplifiers
g. Multipliers and modulators
h. High frequency amplifiers
i. Comparators
j. Voltage regulators
k. Active RC networks

7. Methods of Evaluating Outcomes

Quizzes and examinations.

8. Text and References

IC OP-AMP Cookbook, Walter G. Jung, Howard W. Sams & Co., Inc.
Operational Amplifiers & Linear Integrated Circuits, Robert F. Coughlin & Prentice-Hall, latest edition.

FOOTHILL COLLEGE
Engineering/Technology Division

1. Catalog Description — Course Outline — February 1980

Electronics 65 — Communications Circuits — 5 Units

Prerequisites: Electronics 53 or 53B

Four hours lecture, three hours laboratory.

Study of communications electronics circuits, their organization, theory, operation, and practice. Radio Frequency Amplifiers and Oscillators in transmitters and receivers, transmission lines, modulation, antennas and practical troubleshooting.

2. Required Background of Experience

The student should possess a working knowledge of the circuit analysis techniques developed in Electronics 53.

3. Expected Outcomes

The student will be able to apply standard circuit analysis theory and techniques to the alignment, and troubleshooting of communications circuits in transmitters and receivers. Through laboratory work, the student will develop familiarity with the selection and effective use of basic instruments.

4. Minimum Student Materials

Notebook, pencils, electronics tools.

5. Minimum College Facilities

Classroom and standard electronics laboratory.

6. Expanded Description of Content and Method

A. Introduction to communications circuits
   1) Basic elements and organization of communications circuits.
   2) Noise and other limiting factors: efficiency, line of sight transmission paths, bandwidth, antenna patterns, reflections (ghosts), and power.
   3) Communications systems (in the human context) as an element of culture, enhancing and extending human senses.

B) Resonant circuits
   1) Voltage gain, impedance and bandwidth of series resonant circuits.
   2) Current gain, impedance and bandwidth of parallel resonant circuits.
   3) The role of resonant circuits in communications systems.

C. RF Amplifiers in Transmitters and Receivers
   1) Gain in RF amplifiers: typical loads and their adjustment.
   2) Classes of operation: efficiency, distortion, and power gain.
   3) Frequency multipliers.
   4) RF power amplifiers.

D. RF Oscillators in Transmitters and Receivers
   1) Introduction to oscillators: general requirements and applications.
   2) Feedback as a required (desired) element.
   3) Feedback as an undesired element.
   4) Various types of oscillator circuits.

E. Amplitude Modulation
   1. Introduction to Amplitude Modulation.
   2. AM waveforms.
   3. Frequency distribution and modulation index.
   4. AM voltage considerations.
   5. AM power considerations.

F. Frequency Modulation
   1. Introduction to Frequency Modulation.
   2. Characteristics of Frequency Modulation: Mathematical analysis, frequency distribution, and deviation.
   3. Phase modulation.
   4. Comparison of AM and FM.
   5. Narrow band FM.
   6. Preemphasis circuits.
   7. FM stereo.
   8. Methods of generating FM signals.

G. AM and FM receivers
   1. Introduction to receivers.
   2. Tuned Radio Frequency (TRF) receivers, their problems and limitations.
   3. Superheterodyne Receivers.
   4. Mixers and converters.
   5. Image frequency rejection.
   6. If amplifiers: Alignment by AM signal injection vs. alignment by FM signal injection.
   7. Automatic Gain Control (AGC).
   8. Beat Frequency Oscillator (BFO).
   9. AM and FM detection.
   10. Automatic Frequency Control (AFC).
   11. Deemphasis circuits in FM.
   12. Stereo receivers.

H. Transmission lines
   1. Introduction to transmission lines.
   2. Losses, characteristic impedance, standing waves.
   3. Resistive/reactive loading.
   4. Properties of quarter and half wavelength lines.

I. Antennas
   1. Introduction to antennas.
   2. Antenna principles and parameters.
   3. Antenna ground effects.
   4. Directional antennas.

J. Miscellaneous communications systems
   1. Pulse modulation.
   2. Single Side Band (SSB).
   3. Telemetry
   4. Radar.

K. Microwave communications (optional if time permits)
   1. Microwave oscillators.
   2. Microwave antennas.
   3. Waveguides
   4. Microwave instrumentation and application.

7. Methods of Evaluating Outcomes

Quiz grades and examinations will be weighed with lab notebook grades and subjective evaluation of student performance in assigned lab and classroom work.

8. Texts and References

Lapatine, Sol, Electronics in Communications, John Wiley, 1978.
Reference: Long, William E. Getting Started in Electronics Troubleshooting, Reston Pub. Co., 1979.

FOOTHILL COLLEGE

Engineering/Technology Division

1. Catalog Description — WINTER 1977

Electronics 70 INTRODUCTION TO MICROPROCESSOR SYSTEMS

Prerequisites: Engineering 1 (or equivalent), Electronics 58, Electronics 59 (may be taken concurrently).

Four hours lecture, three hours laboratory. 5 Units

The study of microprocessor systems. Major course topics include system architectures, machine cycle timing and signal flow, assembly and machine language programming and elementary peripheral interfacing. Course emphasis is on programming and interfacing to an existing microprocessor system.

2. Required Background of Experience

None beyond the prerequisites.

3. Expected Outcomes

After successfully completing the course the student will be able to:

1) Write, enter and run simple diagnostic machine language programs on the μP trainer system.
2) Correctly interface several simple input/output devices to the μP trainer system.
3) Expand or reconfigure memory used by the μP trainer system.
4) Ascertain μP trainer system status at any time by interpreting major system status and control lines.
5) Locate a system malfunction down to the part level on the μP trainer system.

4. Minimum College Materials and Facilities

Text, paper, pencils, classroom, electronics stockroom and laboratory, μP trainer system, access to a cross-assembler.

5. Expanded Description of Content and Method

A. Preliminary screening exam intended to point out student prerequisite deficiencies. Exam to cover both hardware and software concepts. Follow up with review guide to correct deficiencies.

B. MST-80 discussion at system level.

System block diagram, correlation to physical layout. Sample Program enter/examine/run. Preliminary discussion of "a program", program execution relative to clock, μP registers, address bus, data bus and memory. This unit intended to give the student a "big picture feel" for microprocessor system signal flow.

5. Expanded Description of Content and Method

C. Elementary assembly language programming.

Programming using ADD, SUB, INR, INX, DCR, DCX, JMP, Conditional JMP, MOV, MVI, LXI, HLT, NOP, OUT, Ø instructions. Status flags C and Z. All programs to be simple and manually assembled, loaded at keyboard. All output to LED displays. Several examples, programs.

D. Elementary Input/Output using MST-80 I/O ports.

Timing and level/impedance considerations. Software timing loops, latches, ASCII code, R-2R ladder D/A conversion, IN D8, OUT D8 instructions. Input devices: switches, TTL outputs. Output Devices: LED's, R-2R ladder. If time permits, use ASR-33 TTY as an I/O device.

E. Detailed discussion of MTS-80 system.

Machine cycle structure, status signals, clock, address bus, data bus, system controller and bus driver, R/W memory ROM memory, I/O ports, single step.

F. Memory structures.

Expanding memory with differently organized memory chips, chip select decoding, memory mapped I/O, R/W, ROM, EPROM, memories. Erasing, programming and verifying EPROM program.

G. More Assembly language programming.

Logical instructions, rotate instructions, stack operations, subroutines, BCD arithmetic. Student to write, assemble load run program using cross assembler on Foothill HP Access Syster.

*H. Interrupt handling.

INT REQ, INTE, INTA Signals, RST instructions, RST instruction jamming, prioritized interrupts.

*I. Discussion of the MTS-80 monitor program.

*J. Discussion of other common microprocessors.

Other microprocessors (including at least 6800) compared and contrasted with 8080 at block diagram level.

* Note: Units A through G constitute required course material. Units H through J optional.

6. Methods of Evaluating Outcomes

Quizzes, midterms, laboratory projects and a final exam will be weighted to determine course objective accomplishments.

7. Texts and References

INTEL Corp.	INTEL 8080 Microcomputer Systems User's Manual. Intel Corporation 3065 Bowers Avenue Santa Clara, CA 95051 (408) 246-7501
Lab Notes	Foothill Electronics 70 Course Notes

8. Ramirez, Microprocessing Fundamentals
McGraw-Hill.

FOOTHILL COLLEGE

Engineering/Technology Division

1. Catalog Description — Winter 1977

Elec. 71 — ELECTRONIC MATHEMATICS — 5 Units

Prerequisites: Mathematics 200 or qualifying score in counseling examination. Strongly recommend that Electronics 51 be taken concurrently.

Five hours lecture.

Application of mathematical principles and processes to electronics. Scientific notation, electrical units, electronic calculator use, expression simplification, first degree equations and equalities, error analysis, simultaneous linear equations, transient exponentials, trigonometric functions and complex numbers.

2. Required Background of Experience

It is strongly recommended that the student be concurrently enrolled in Electronics 51.

3. Expected Outcomes

The student will acquire proficiency in all the mathematical techniques used in Electronics 51.

4. Minimum Student Materials

Four function electronic calculator.

5. Minimum College Facilities

An adequate classroom with chalkboard; some device for rapid graphing on chalkboard.

6. Expanded Description of Content and Method

a. Scientific Notation — Approx. Completion Date
b. Electrical Units

---------- day 5

c. Electronic calculator:

1) Addition 2) subtraction 3) Multiplication 4) Division 5) chain-operations

---------- day 10

d. Expression Simplification f. First Degree Inequalities
e. First Degree Equations

---------- day 20

g. Error Analysis - - Absolute, Percent

---------- day 25

6. Expanded Description of Content and Method (con't.

h. Simultaneous Linear Equations:

1) Solution by Elimination
2) Solution by Determinants

----------day 35

i. Transient Exponentials:

1) Exponential Expression Evaluation.

Forms: $y = Ae^{-t/\tau}$; $y = A(1 - e^{-t/\tau})$

2) Natural Logarithms:

Forms: $t = -\tau\ln(y/A)$; $t = -\tau\ln(y/A-1)$

----------day 45

j. Trigonometrical functions

1) Preliminary discussion of a sinusoidal voltage, current or power versus time sufficient to carry student through first two weeks of Electronics 52. Discussion to touch on:

a) Amplitude (peak, peak-peak, average, r.m.s.).
b) Frequency (Hz, radians/sec, degrees/sec).
c) Period.
d) Phase, phase difference between two signals (degrees/radians).
e) Phasor representation.
f) Determination of above quantities from graph or oscilloscope display.

----------day 55

Note: This outline is designed to parallel and anticipate Electronics 51 course material. To insure the smooth development of both courses, the order of material presentation and the approximate topic times must be closely observed.

7. Methods of Evaluating Outcomes

Several one-hour examinations and unannounced short quizzes will be used to provide a constant measure of the class's grasp of current material coverage. Daily problem assignments are made, graded, and returned to the student as soon as possible. Classroom problem sessions are used in further evaluation by requiring groups of students to work various exercises on the chalkboard for critical analysis by the rest of the class. A one-hour midterm and a two-hour final examination are given. These are problems solving types of examinations.

8. Texts and References

Mathmetics For Electronics D.P. Leach Reston

FOOTHILL COLLEGE

Engineering/Technology Division

1. Catalog Description — Spring 1976

Electronics 72 ELECTRONICS MATHEMATICS 5 Units

Prerequisite: Electronics 71, Electronics 51. Strongly recommended that Electronics 52 be taken concurrently.

Five hours lecture.

Mathematical principles and processes involved in elctronics. Review of trigonometric functions. Complex numbers, logarithms, decibels, log-log and semi-log graphing, simple Bode plots, introduction to calculus.

2. Required Background of Experience

None beyond the prerequisites.

3. Expected Outcomes

The student will acquire proficiency in all mathematical techniques used in Electronics 52, and subsequent electronics core courses.

4. Minimum Student Materials

Electronic Calculator with trigonometric functions.

5. Minimum College Facilities

An adequate classroom with chalkboard.

6. Expanded Description of Content and Method

	Approximate Completion Date
A. Trigonometric Functions 1) Geometric Interpretation a. Right triangle problems (Review) 2) Waveforms (Review) a. Amplitude b. Frequency c. Period d. Phase	
----------	day 5
B. Complex Numbers 1) Rectangular/Polar Representations 2) Calculator Rectangular/Polar Transformations 3) Expression Evaluation 4) Phasors (Review)	
----------	day 10
5) Equations with Complex Coefficients a. First Degree Equations b. Simultaneous Linear Equations 6) Quadratic Theorem	
----------	day 20

6. Expanded Description of Content and Method, cont.

C. Logs, Decibels

D. Log-Log, Semi-Log Graphing. Simple Bode Plots.

----------day 30

E. Introduction to Calculus

1) Functions of One Variable
2) Elementary Limit Concepts
3) Graphical Interpretation of a Derivative
4) Derivatives of Polynomial Functions
5) Graphical Interpretation of a Definite Integral
6) Definite Integrals of Polynomial Functions
7) Applications to Simple Passive RL, RC circuits; Active Integrating, Differentiating Circuits.

----------day 55

Note: This outline is designed to parallel and anticipate Electronics 52 course material. To insure the smooth development of both courses, the order of material presentation and the approximate topic times must be closely observed.

7. Methods of Evaluating Outcomes

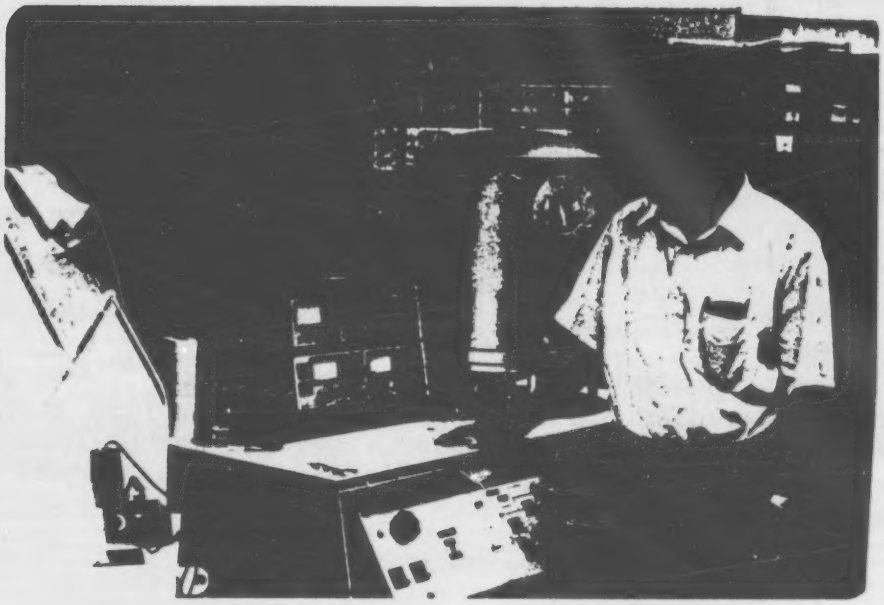
The following type of testing is applied: daily homework, weekly quizzes, one-hour exams, and a final exam.

8. Texts and References

D.P. Leach, Mathmetics for Electronics, Reston

Richmond, Calculus For Electronics, latest, McGraw-Hill.

FOOTHILL SEMICONDUCTOR PROCESSING MAJOR



The Santa Clara Valley is the birthplace of integrated circuit technology and the home of some of the largest semiconductor manufacturing companies in the nation. Numerous smaller semiconductor manufacturers and many companies that provide services, equipment or supplies used by the semiconductor industry are also located in this region. This large concentration of companies in fields related to semiconductor processing technology provides a large number of employment opportunities for a person with background and experience in the field of semiconductor processing.

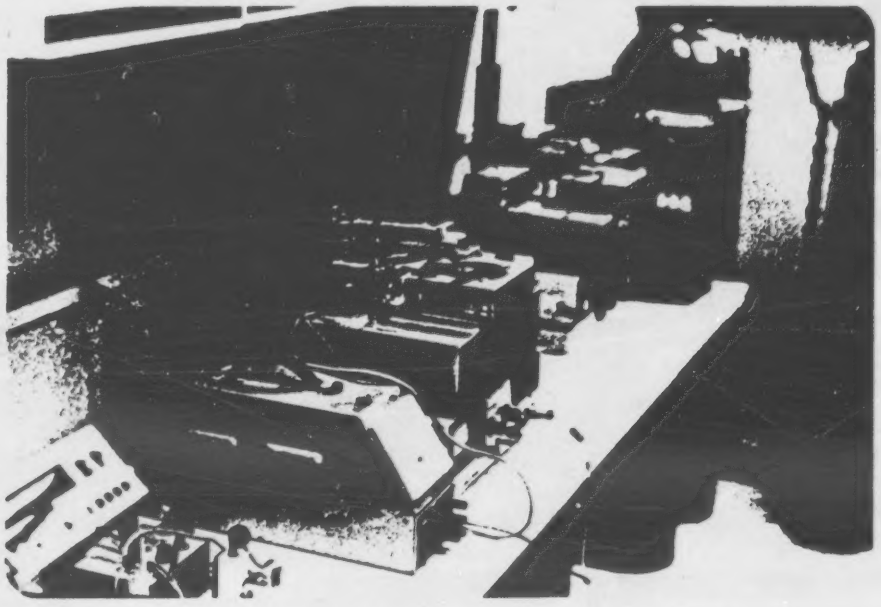
FOOTHILL SEMICONDUCTOR PROCESSING MAJOR

First Year Curricula

Fall Quarter	Winter Quarter	Spring Quarter
SP 50 Intro to S.P.	SP 53 Diffusion	SP 55 Deposition
SP 51 Photomasking	Elex 60 Survey of Elex.	
Engr 2 Engr Prof.		

Second Year Curricula

SP 62 Device Physics	SP 63 Wafer Fabric.	Engr. 1 Comp App
Engr 70 Tech Math		



FOOTHILL COLLEGE

Engineering/Technology Division

MICONDUCTOR PROCESSING 50 Winter 1977

1. Catalog Description

S.P. 50 Introduction to Semiconductor Processing 3 Units

Three hours lecture.

Prerequisites: None

An introduction to the field of semiconductor processing intended to provide an overview of the industry, including job requirements and opportunities.

2. Expected Outcomes

The student will learn:

a. The history of the semiconductor industry.
b. The type of equipment used and typical facility layout.
c. The steps followed in device manufacturing.
d. Vocabulary.
e. Types of devices; cross-sectional and topographic views.
f. Basics of semiconductor materials.

3. Minimum Facilities and Equipment

Classroom; viewgraph or slide projector; microscope and other displays; hand-outs and notes.

Expanded Description of Content and Method

a. History of the semiconductor industry

b. Materials used in semiconductor fabrication
   1) Semiconductor materials and properties
   2) Metals
   3) Chemicals and Review of Periodic Chart

c. Properties of semiconductor materials
   1) Undoped (intrinsic)
   2) Doped (extrinsic)

d. Brief outline and description of
   1) Crystal Growth
   2) Epitaxy
   3) Diffusion
   4) Photoresist
   5) Metallization
   6) Testing

e. Fabrication Procedures
   1) Chemical cleaning
   2) Photomasking
   3) Diffusion
   4) Crystal Growth
   5) Metallization
   6) Testing (in process)

f. Brief look at equipment used in manufacturing of devices

g. Introduction to Devices
   1) Diodes
   2) Xistors
   3) I.C.s
   4) MOS devices

h. Packaging introduction

5. Methods of Evaluating Outcomes

Student progress and accomplishment will be evaluated through consideration of the quality of work assignments, performance on periodic quizzes, and performance on examinations.

6. Texts and References

Semiconductor and Integrated Circuit Fabrication Technique., Blanchard/Fairchild, Restin Publishing Co.

FOOTHILL COLLEGE

Engineering/Technology Division

SEMICONDUCTOR PROCESSING 51 Winter 1977

1. Catalog Description

S.P. 51 PHOTOMASKING 4 Units

Three hours lecture; two hours lecture/laboratory

Prerequisites: S.P. 50 (may be taken concurrently)

An introduction to photomasking and its uses in semiconductor device fabrication.

2. Expected Outcomes

The student will learn:

a. What photoresis is and what it can be used for in device processing.
b. The different types of photoresist.
c. Photomasking techniques.
d. Mask making techniques.
e. About equipment used in photomasking.

The student will qualify for employment as:

a. Photomask makers
b. Photoresist technicians or operators

3. Minimum Facilities and Equipment

Classroom, microscope, viewgraph or slide projector, displays of masks, rubies and masked wafers. Light table.

4. Expanded Description of Content and Method

a. Types of photoresists (negative and positive).
b. Operation mechanism of different photoresists.
c. Application of photoresist.
d. Equipment for expose of pattern using photoresist.
e. Development techniques.
f. Problem area in using photoresist.
g. Typical setup and operation of a photoresist room.
h. Advantaged exposure techniques (electron beam and projection (reduction) alignment).

5. Methods of Evaluating Outcomes

Student progress and accomplishment will be evaluated through consideration of the quality of work assignments, performance on periodic quizzes, and performance on examinations.

6. Texts and References

To be selected.

FOOTHILL COLLEGE
Engineering/Technology Division

Semiconductor Processing 52A SPRING 1980

1. Catalog Description

S.P. 52A BiPolar Integrated Circuit Layout 4 Units

Prerequisite: S.P. 50

Two hours lecture, 2 hours lecture/lab. 3 hours lab.

Methods and techniques of integrated circuit layout. Semiconductor device characteristics affecting layout. A survey of current industrial practices.

2. Required Background of Experience

Adequate preparation for college level course work.

3. Expected Outcomes

The student will acquire the necessary background to seek employment in a facility doing bipolar integrated circuit design and layout. This background will include a familiarity with drafting and integrated circuit fabrication technology, and the ability to perform the layout of devices and simple circuits using bipolar technology.

4. Minimum Student Materials

Notebook, assigned text(s); writing materials, and drafting supplies as may be deemed appropriate.

5. Minimum College Facilities

Classroom with drafting tables (or flat topped tables), adequate lighting, chalkboards, and facilities for showing films or slides.

6. Expanded Description of Content and Method

A. Overview of integrated circuit layout as part of device manufacture.

1. History of the field.
2. Skills involved in circuit layout.
3. Relationship between circuit layout and related areas.

B. Design Rules and their derivation.

1. Review of fabrication techniques and their tolerances.
2. Bipolar design rules.

C. Layout considerations.

1. Physical constraints
2. Electrical constraints
3. Thermal constraints

D. Layout of typical bipolar integrated circuits.

1. Linear Circuits

6. Expanded Description of Content and Method

a. Devices in linear circuits

1. NPN transistors
2. PNP transistors
3. Diodes
4. Resistors
5. Capacitors

b. Digital

1. NPN transistors
2. Diodes
3. Resistors

7. Methods of Evaluating Outcomes

Grades will be based on class participation, work assignments, quizzes, exams, projects, and a final exam.

8. Texts and References

Appropriate texts will be selected by the instructors from available publications which are current, scholarly, and relevant to the subject matter of this course.

FOOTHILL COLLEGE
Engineering/Technology Division

Semiconductor Processing 52B Spring 1980

COURSE OUTLINE

1. Catalog Description

S.P. 52B MOS Integrated Circuit Layout - Part I 4 Units

Prerequisites: S.P. 50 suggested.

Two hours lecture, 2 hours lecture/lab, 3 hours lab.

The first quarter of this two-quarter class is designed to provide the student with some of the basics of MOS design.

2. Required Background of Experience

Adequate preparation for college level course work.

3. Expected Outcomes

This class is intended to introduce the student to the basic building blocks of an integrated circuit. This background will include a familiarity with the layout of transistors and simple logic functions.

4. Minimum Student Materials

Notebook, assigned text(s); writing materials, and drafting supplies as may be deemed appropriate.

5. Minimum College Facilities

Classroom with drafting tables (or flat topped tables), adequate lighting, chalkboards, and facilities for showing films or slides.

6. Expanded Description of Content and Method

A) Basic logic symbols

1. Inverters
2. OR's
3. NOR's
4. AND's
5. NAND's

B) Conversion of logic symbols to schematic form

1. Pull-ups
2. Pull-downs
3. Nodes
4. Transmission Devices

C) The Source, Drain, Gate Relationships

D) Measurement

1. Metric
2. English
3. W/L

6. Expanded Description of Content and Method

E. The Basic Structure of a Transistor

1. Cross-section of a gate
2. Fabrication of a transistor
3. How a transistor works

F. Design Rules

1. The origin
2. Application
3. Mis-Alignment

G. Problems with large gates

1. Calculating corners
2. Calculating angles
3. Critical stack-up

H. Interconnectors

1. Diffusion
2. Buried contacts
3. Poly silicon
4. Oxide contacts
5. Aluminum

I. Exclusive NOR's

J. Layout of static memory cell

1. Optimization of interconnects
2. Minimization of area

K. Depletion Mask

L. Capacitors

M. Cells, Orientations and Placement

N. Decoders X and Y

O. Electrical constraints

1. Resistance and its measurement
2. Capacitance and its measurement.

7. Method of Instruction

A combination of lectures, lab, notes and homework will be utilized.

8. Method of Evaluation

Tests 40%, Memory Cell 10%, Decoders 10%, Final 35%, Instructor's Evaluation 5%.

9. Texts and References

None, notes and articles will be provided in class.

FOOTHILL COLLEGE
Engineering/Technology Division

Semiconductor Processing 52C SPRING 1980

Course Outline

1. Catalog Description

   S.P. 52C MOS Integrated Circuit Layout - Part II 4 Units

   Prerequisites: S.P. 52B required.

   Two hours lecture, 2 hours lecture/lab, 3 hours lab.

   The second quarter of this two- uarter class is designed to familiarize the student with the methods and techniques of integrated circuit layout. This class will enable the student to assemble the basic building blocks of MOS design into a total composite.

2. Required Background of Experience

   Adequate preparation for college level course work.

3. Expected Outcomes

   The student will acquire the necessary background to seek employment in a facility doing MOS integrated circuit design and layout. This background will include a familiarity with drafting and integrated circuit fabrication technology, and the ability to perform the layout of devices and simple circuits using MOS technology.

4. Minimum Student Materials

   Notebook, assigned text(s); writing materials, and drafting supplies as may be deemed appropriate.

5. Minimum College Facilities

   Classroom with drafting tables (or flat topped tables), adequate lighting, chalkboards, and facilities for showing films or slides.

6. Expanded Description of Content and Method

   a. Terminology
   b. CHIP Organization
   c. Bussing Plans
      1. Power Bussing
      2. Signal Bussing
      3. Bonding Pad Location
      4. Generator Cell Location
      5. Current Density
   d. Input Protection Devices
   e. Device Density
   f. Schedules
   g. Binary Number System
   h. Scribe Lines
   i. Alignment Targets
   j. Output Buffers
   k. Address Input Buffers
   l. CHIP Size Calculation
   m. Digitizing

6. Expanded Description of Content and Method

n. Computer Aided Graphics
o. Digitized Plots and Film Checking
p. Computerized Reticle Generation
q. Step and Repeat Master Plates
r. Bonding Diagrams
s. Complimentary MOS
t. Double-Poly Technology
u. Charged Coupled Devices
v. PROM

7. Texts and References

None, notes and articles will be provided in class.

8. Methods of Evaluating Outcomes

A combination of lectures, lab, notes and homework will be utilized

Evaluation:	Tests	20%
	Address Buffer	10%
	I/O Buffer	10%
	Composite	10%
	Final	25%
	Instructor's Evaluation	5%

FOOTHILL COLLEGE
Engineering/Technology Division

Semiconductor Processing (SP 52D) Spring 1980

Course Outline

1. Catalog Description

S.P. (52D) Advanced Integrated Circuit Layout 4 Units

Prerequisites: S.P. 52A

Two hours lecture, two hours lecture/lab, three hours lab

Methods and techniques of advanced integrated circuit layout. Semi Conductor device characteristics affecting layout including Schottky, and and dual layer metal technology.

2. Required Background of Experience

Adequate preparation for college level course work

3. Expected Outcomes

With the completion of this course in conjunction with S.P. 52A, the student will acquire the necessary background to seek employment in a facility doing bipolar integrated circuit design and layout. This background will include a familiarity with drafting and integrated circuit fabrication technology, and the ability to perform the layout of devices in complex circuits using bipolar technology.

4. Minimum Student Materials

Notebook, assigned text (s), writing materials, and drafting materials as may be deemed appropriate.

5. Minimum College Facilities

Classroom with drafting tables (or flat topped tables), adequate lighting, chalkboards, and facilities for showing films, slides and transparancies or overlays.

6. Expanded Description of Content and Method

A. Review
   1. R eview of fabrication techniques, their tolerances, and how they affect design rules
   2. General Bi Polar design rules
   3. Specific design rules that will apply to project
   4. Review of relationship between circuit layout and related areas
   5. Job opportunities and potentials

B. Schottky washed emitter technology as applied to project
   1. NPN transistors
   2. PNP transistors
   3. Diodes
   4. Resistors

C. Applying cell and sub cell concepts on:
   1. stick hookup
   2. paste-up
   3. drawing

D. Periphery drawings and what they can consist of.

E. Bridges, crossovers and dual layer metal
   1. N +
   2. Base
   3. Sinker technology
   4. Isolation
   5. Buried layer
   6. Dual layer and vias

F. Project Octal D flip flop with output and clock enables.
   1. single layer metal approach
   2. bridges - sinkers washed
   3. cell concept
   4. stick hookup
   5. paste-up
   6. drawing
   7. differences in dual layer approach

G. Counters and Multipliers
   1. Logic types
   2. Schematic types
   3. Formalized layout
   4. Group discussion on methods

H. Field trip to a facility in the Bay Area, either a design group or fab. area, or a masking facility.

7. Methods of Evaluating Outcomes

Grades will be based on class participation, work assignments, quizzes, exams, final project, and a final exam.

8. Texts and References

Appropriate texts will be selected by the instructors from available publications which are current, scholarly, and relevant to the subject matter of this course. Handouts will be used to implement these where needed.

9. Career Opportunities

The class makeup will closely approximate a working environment and will help the student obtain a job in this area.

FOOTHILL COLLEGE

Engineering/Technology Division

Winter 1976

SEMICONDUCTOR PROCESSING 53

1. Catalog Description

S. P. 53 DIFFUSION 4 Units

Prerequisites: S.P. 50 (may be taken concurrently)

Three hours lecture; two hours lecture/laboratory

An introduction to solid state diffusion methods with emphasis on control and measurement, and methods of introducing impurities into the semiconducting material.

2. Expected Outcomes

The student will learn:

a. What are impurities and what are their functions.
b. How to introduce controlled amounts of impurities into materials.
c. How to measure quantitatively the amount.
d. Different types of impurities and how they act electrically.
e. Diffusion mechanics, simple theory.
f. Use of barrier layers to prevent diffusion in certain areas.

The student will qualify for employment as:

a. Diffusion Technician Trainee
b. Diffusion Operator

Minimum Facilities and Equipment

Classroom, microscope, viewgraph or slide projector, chemical chart, samples of semiconductors and other displays.

4. Expanded Description of Content and Method

a. Review of semiconducting materials
b. Review of impurity materials
c. Diffusion mechanics and theory in different materials: Ge, Si, GaAs, GaP.
d. Conduction mechanics when impurities are in material.
e. Methods of introducing buried layers (As and S's)
f. Methods of introducing p-type materials
g. Methods of introducing n-type materials
h. Learn typical diffusion cycles for different devices and/or ICs.
i. Dielectric layer growth techniques
   1) SiO_2, thermal and deposited.
   2) SiNx, deposited
j. Sample preparation before diffusion
k. Survey of diffusion equipment used
l. Survey of measurement techniques
m. Typical diffusion room setup and operation

5. Methods of Evaluating Outcomes

Student progress and accomplishment will be evaluated through consideration of the quality of work assignments, performance on periodic quizzes, and performance on examination.

6. Texts and References

To be selected.

FOOTHILL COLLEGE

Engineering/Technology Division

SEMICONDUCTOR PROCESSING 54 Winter 1978

1. Catalog Description

S.P. 54 THICK/THIN HYBRID CIRCUITS 4 Units

Prerequisites: S.P. 50 (may be taken concurrently) or consent of instructor.

Four hours lecture; two days/evenings per week.

Thick/thin hybrid circuit layout techniques and methods used for manufacture. Student will layout a hybrid design, cut ruby, prepare manufacturing plans and critique his design through each of the manufacturing operations. Reliability, quality assurance and cost considerations will be addressed.

2. Required Background of Experience

Adequate preparation for college level course work.

3. Expected Outcomes

The student will learn:

a. Hybrid technology and terminology.
b. Thick film hybrid design rules. Design an actual hybrid and cut ruby.
c. Thin film hybrid design rules. Design an actual hybrid and cut ruby.
d. Packaging of the circuit-partitioning considerations.
e. Mask making and photoresist operations.
f. Materials, substrates, special package designs.
g. Assembly methods, die attach, wire bonding, beam leads, flip chips, automatic assy. methods, tape bonding and carriers.
h. Facilities, testing and optimum costing.

The student will qualify for employment as:

a. Thick/thin hybrid layout designer.
b. Assembly operations-trainee.
c. Hybrid planning operations.
d. Inspector in hybrid assy.-trainee

4. Minimum Student Materials

Notebook, 3-ring binder for handouts (2), drafting tools, scale, triangles, exacto knife and normal writing materials.

5. Minimum College Facilities

Classroom with drafting tables (or flat topped tables), adequate lighting, chalkboards, and facilities for showing slides. Will show samples of hybrids and designs.

6. Expanded Description of Content and Method

a. Introduction-short review of printed circuit board design and welded electronics as a lead-in into hybrid microelectronics

6. Expanded Description of Content and Method

b. Microelectronics technology, structures and terminology, handout and review design syllabus.

c. Hybrid and integrated circuit design considerations, thick/thin films-bipolar metal oxide semiconductor.

d. Partitioning of circuit, make/buy decisions, geometric restrictions, performance, cost, testing, reliability, quality assurance and manufacturing considerations.

e. Handout term project-(hybrid) design for thick and thin film hybrid. Grid paper 10 lines/inch required.

f. Design rules for thick/thin hybrids, layout methods, tolerances and measurements.

g. Art work, ruby cutting, coordinatograph layout, photo reduction systems and general mask making operations.

h. Fabrication of thick/thin film hybrid substrate materials, conductors, resistors, dielectric insulators, evaporation, electron beam and sputtering, multilayer systems.

i. Assembly operations, metal and epoxy chip attachment systems, wire bonding, beam leads, flip chips, mechanical bonding systems, carriers and tapes, cover attachment systems metal and epoxy, packages, flatpacks and T.O. cans.

j. Class review of term project and comments on each students project.

7, Methods of Evaluating Outcomes

Student will be evaluated on class participation, work on term project, quizzes, midterm and final examination.

8. Texts and References

Published texts will be for references only. The instructor will make available a syllabus, hybrid design rules and handouts current with todays "state of the art" relevant to the subject matter of this course.

FOOTHILL COLLEGE
Engineering/Technology Division

Spring 1979

SEMICONDUCTOR PROCESSING 55

1. Catalog Description

S. P. 55 DEPOSITION 4 Units

Three hours lecture; Two hours lecture/laboratory

Prerequisites: S.P. 50 (may be taken concurrently)

An introduction to the different types of depositions that are used in the industry. To include Vacuum Deposition and Chemical Vapor Deposition.

2. Expected Outcomes

The student will learn:

a. Techniques of evaporating contacting metal layers for semiconductors.
b. Techniques for CVD; silicon, Col. III and Col. V elements, and SiO_2 layers.
c. Techniques of sputtering and plating of metals.
d. Techniques of etching of metals and chemicals used in the processes.
e. Vacuum systems and deposition equipment.

The student will qualify for employment as:

a. Evaporation technicians
b. Deposition (epitaxial) specialists
c. Metal deposition trainee or operator

3. Minimum Facilities and Equipment

Classroom, microscope, viewgraph or slide projector, displays and samples of devices and/or circuits using techniques.

4. Expanded Description of Content and Method

a. Review of semiconducting materials.
b. Description of epitaxy growth techniques and simple theory.
c. Description of uses of epitaxy layers.
d. Description of sputtering techniques, simple theory and uses.
e. Vacuum system descriptions.
f. Typical evaporation cycles.
g. Typical materials that are evaporated for metallization.
h. Simple theory of metallization (ohmic contacts).
i. Masking and etching metal layers.
j. Sample preparation before metallization and importance as well as pre-epitaxial cleaning techniques.
k. Deposition of dielectric layers (SiO_2 and SiNx)

5. Methods of Evaluating Outcomes

Student progress and accomplishment will be evaluated through consideration of the quality of work assignments, performance on periodic quizzes, and performance on examinations.

6. Texts and References

To be selected.

FOOTHILL COLLEGE

Engineering/Technology Division

Semiconductor Processing 62 Spring 1980

1. Catalog Description

S.P. 62 Device Physics 4 Units

Three hours lecture; two hours lecture/laboratory

Prerequisites: Engineering 70, S.P. 51, 53, and 55.

An introduction to the physics of semiconductor devices, including operating characteristics and parameters. Coverage will include resistors, diodes, bipolar transistors, junction field effect transistors (JFETs), insulated gate field-effect transistors (MOSFETs and SIGFETs), capacitors and parasitic devices.

2. Expected Outcomes

The student will learn:

a. Fundamentals of semiconductor material properties.
b. Fundamentals of semiconductor device operations.
c. Methods of measuring characteristics and parameters of semiconductor devices.

3. Minimum Facilities and Equipment

Viewgraph or slide projector, packaged devices, curvetracers (i.e., tektronix 575 or 576), 4-point probe.

4. Expanded Description of Content and Method

a. Review of the properties of semiconductors.
   1) Crystal structure of semiconductors
   2) Properties of intrinsic semiconductors.
   3) Properties of extrinsic semiconductors.
   4) Temperature effects on carrier concentration and mobility.
   5) Resistivity and conductivity.
   6) Transport of carriers in a semiconductor.
   7) Carrier lifetime in semiconductors.

b. Bipolar Technology and devices
   1) Review bipolar process steps
   2) Resistors - electrical characteristics
      a. Base
      b. Pinched base
      c. Emitter
      d. Epitaxial

3) Diodes -electrical characteristics
4) Capacitors - electrical characteristics
5) Bipolar Transistors - electrical characteristics
   a. NPN
   b. PNP
6) Junction Field effect transistors - electrical characteristics.

c. MOS Technology and devices

1) Review of MOS process steps
2) Resistors - electrical characteristics
3) Capacitors - electrical characteristics
4) Insulated - gate field effect transistors
5) Gate protection devices
6) Parasitic devices

5. Methods of Evaluating Outcomes

Student progress and accomplishment will be evaluated on the basis of performance on work assignments, periodic quizzes and examinations.

6. Texts and References

Measurement Concepts: Semiconductor Device Measurement (Tektronix).

FOOTHILL COLLEGE
Engineering/Technology Division

Spring 1980

SEMICONDUCTOR PROCESSING 63

Catalog Description

S. P. 63 WAFER FABRICATION 4 Units

Three hours lecture; two hours lecture/laboratory

Prerequisites: Eng 70 , Elec. 60, S.P. 51, 53, and 55.

A detailed presentation of the steps followed in semiconductor wafer fabrication. Coverage of discrete components and integrated circuits including bipolar, MOS, and LED devices.

2. Expected Outcomes

The student will learn:

a. Operation of a wafer fabrication area
b. How to organize an efficient fabrication area
c. Types of equipment available for maximum yields
d. Philosophy of wafer fabrication
e. Trouble shooting techniques in processing
f. Safety considerations

3. Minimum Facilities and Equipment

a. Viewgraph and slide projector.
b. Microscope, curvetracer and probe station.

4. Expanded Description of Content and Method

a. Field trips to existing wafer fabrication facilities.
b. Typical layout of facilities. (Equipment included)
c. Typical procedures that go into making discrete devices and integrated circuits.
d. A look at fabricating state of the art devices.
e. Clean room considerations.
f. D.I. water processing. Typical water purification setups.
g. Quality assurance
h. Survey of equipment vendors
i. Trends in newer facilities (LSI)
j. Inter-relationships in processing steps: structures of devices including LED's, transistors, diodes, IC's and MOS devices; electrical characteristic alterations due to process variations and topological variations.
k. Trouble shooting techniques in processing.

5. Methods of Evaluating Outcomes

Student progress and accomplishment will be evaluated through consideration of the quality of work assignments, performance on periodic quizzes, and performance on examination.

6. Texts and References

To be selected.

FOOTHILL COMPUTER SERVICE TECHNOLOGY

First Year Curricula

Fall	Winter	Spring
CST 50 Intro to Comp. Tech	Elex 52 AC Circuits	Elex 53 Active Dev. & Circuits
Elex 51 DC Circuits	Elex 72 Elex Math	Engr 1 Programming
Elex 71 Elex Math	CST 55 Customer Relations	

Second Year Curricula

Elex 58 Dig. Elex	Elex 70 Micro Proc.	CST 63 Peripheral Equipment
CST 57 Assembly Language	CST 61 Diag. Prog.	CST 65 Computer Systems

FOOTHILL COMPUTER SERVICE TECHNOLOGY

CST 50 ORIENTATION TO COMPUTER TECHNOLOGY

1 unit. One hour lecture.

Group and individual counseling sessions in which the student is assisted in orientation to college and in planning his educational program. A study of the computer technology profession, its requirements, opportunities and responsibilities; preview of the applications of basic sciences to engineering problems.

CST 51 ELECTRONIC CIRCUITS

5 units. Four hours lecture, three hours laboratory.

DC Circuits: resistance, Ohm's Law, series, parallel circuits, theorems, power, AC circuits: inductance, capacitance, time constant, reactance and impedance, series and parallel circuits, power, series and parallel resonance, instrument, analog meters, digital meters and oscilloscope.

CST 53 ELECTRONIC DEVICES

5 units. Four hours lecture, three hours laboratory.

Semiconductor diodes, the diode as a rectifier, Zener diodes, SCR, LED and LED displays, bipolar transistors, FET's and MOSFETS. The transistor as a switch and as an amplifier. Linear integrated circuits, op-amp, comparator, timer, sample and hold circuits. I.C. regulators and power supplies, vacuum tubes and the CRT.

CST 55 CUSTOMER RELATIONS

2 units. Two hours lecture.

Analysis of the personal skills and attitudes necessary for successful customer relations. Development of interpersonal behavior techniques with an applied understanding of appropriate social conduct in private and public situations. Study of personal and professional responsibility with a focus on the instrumental uses of communication.

CST 57 ASSEMBLY LANGUAGE

5 units. Four hours lecture, three hours laboratory.

Assembly and machine languages. Major topics to include variables, data input/output methods, comparison, inequalities, math operation, switching, transfers and flow charting.

CST 61 DIAGNOSTIC PROGRAMMING

5 units. Four hours lecture, three hours laboratory.

Theoretical and practical aspects of digital computer systems. Operational characteristics and functional analysis of the control processes unit, mathematics unit, storage units, input and output units. Application of machine language and operation theory for trouble shooting. Use of instruments in diagnostic problem solving.

CST 63 PERIPHERAL EQUIPMENT

5 units. Four hours lecture, three hours laboratory.

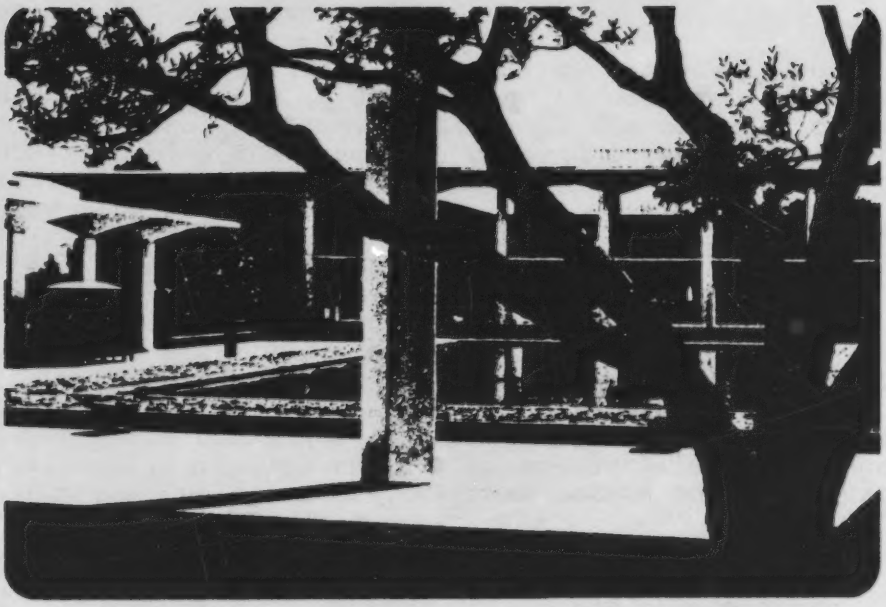
Theory of operation and use of computer peripheral equipment including input devices, output devices and permanent storage units. Familiarization with installation procedures and instruction in training personnel in peripheral equipment operation.

CST 65 COMPUTER SYSTEMS

Two hours lecture.

The internal architecture of the major computer systems currently commercially available will be studied and compared, including subsystem design. Specific commercial applications will be discussed.

COLLEGE OF SAN MATEO



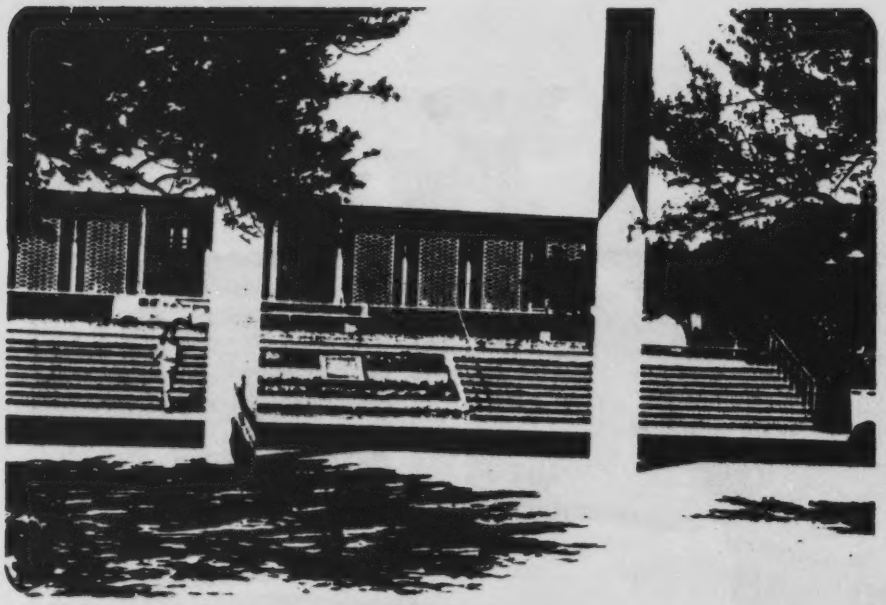
College of San Mateo is located on a 153 acre site that provides a panoramic view of the entire north Bay Area. Completed at a cost of almost $19.5 million, the campus opened its doors in 1963, and currently serves more than 15,000 day and evening students.

The college has an excellent electronics technician program plus a unique Electronics Worksite Training Project.

COLLEGE OF SAN MATEO ELECTRONICS WORKSITE TRAINING PROJECT

Working with the electronics industry, the College of San Mateo established the Electronics Worksite Training Project where work stations, as pictured above, were established both on campus and at industrial sites. In a eight week period students are prepared to enter the electronics field at an entry level. The course is based upon a microprocessor controlled video tape course that was developed at the college.

COLLEGE OF SAN MATEO ELECTRONICS TECHNOLOGY



Associate in Science Degree with a Major in Electronics Technology. REQUIREMENTS:

Electronics Technology 200, 250, 252, 260, 280, 300, 302, 310, 330, 350, 360, 362, 380, 666 ..... 43 Semester Units.

The student will be required to purchase a set of personal tools and supplies for most laboratory classes.

To meet math requirement, E. T. 230, or Math 119 or 120 must be taken concurrently with E. T. 200.

To obtain an A.S. Degree in Electronics Technology students must have a G.P.A. of 2.0 or better in the above courses required for the major.

COLLEGE OF SAN MATEO ELECTRONICS TECHNOLOGY

100 INTRODUCTION TO ELECTRONICS (3) Three lecture hours per week. (Not open to Electronics Technology majors). Basic electronics with a descriptive presentation and a non-mathematical approach. The influence of electronics in all phases of business, science and daily life is stressed, with emphasis on electronic systems.

110 FUNDAMENTALS OF ELECTRONICS (3) Two lecture hours and three lab hours per week. Basic electronic components and circuits are covered using a non-mathematical approach. Laboratory experiences are provided in the use of the basic instruments.

115 ELECTRONICS SOLDERING TECHNIQUES (1) One lecture hour and three lab hours per week for eight weeks. Soldering techniques and skills are applied to wire, components and printed circuits. Proper choice, use and care of hand tools will be covered. Emphasis on neatness as well as workmanship will be stressed.

200 PASSIVE CIRCUITS AND DEVICES (5) Three lecture hours and six lab hours per week. Prerequisite: One year of high school algebra with grade of C or better. Study of the circuit action of significant combinations of resistance, capacitance, and inductance. Experiments and procedures parallel the lecture material presented. The use of basic electronic measuring equipment is stressed.

230 APPLIED ELECTRONIC MATHEMATICS (3) Three lecture hours per week. Prerequisite: One year of high school algebra with a grade of C or better. Basic applications of algebra to the solution of problems involving direct-current circuits, elements of trigonometry, logarithms, complex numbers, and vector methods as applied to alternating current circuits and high-transmission lines.

250 ACTIVE ELECTRONIC DEVICES & CIRCUITS (5) Three lecture hours and six lab hours per week. Prerequisite: E. T. 200 and concurrent enrollment in E. T. 252. Study of the characteristics of active electronic devices such as bi-polar and field-effect transistors, thyristors and vacuum devices. Application of these devices in simple electronic circuits.

252 INSTRUMENTS AND SYSTEMS MEASUREMENTS (2) One lecture hour and three lab hours per week. Prerequisite: E. T. 200 or equivalent qualification, and concurrent enrollment in E. T. 250. A study of measuring equipment and techniques as applied to electronic devices, linear circuits, audio and other electronic systems.

260 DIGITAL LOGIC CIRCUITS I (3) Two lecture hours and three lab hours per week. Prerequisite: E. T. 110 or equivalent qualifications. A study of characteristics of digital electronic circuits that utilize such IC devices as gates, flip-flops and memories.

270 INTRODUCTION TO ELECTRONICS SOLDER ASSEMBLY (1) One lecture hour and three lab hours per week for eight weeks. Familiarization and development of skills in solder assembly techniques.

280 ELECTRICAL/MECHANICAL ASSEMBLY TECHNOLOGY I (2) One lecture hour and three lab hours per week. Prerequisite: Concurrent enrollment in E. T. 250 or equivalent background. Basic hand skills required of electronics technicians. Familiarization with fabrication and assembly techniques typical of the electronics industry with emphasis on quality of workmanship. (Extra supplies required).

300 ANALYSIS LINEAR CIRCUITS (4) Two lecture hours and six lab hours per week. Prerequisite: E. T. 250 or equivalent qualifications. Study of multi-stage linear discrete and IC circuit such as amplifiers. Oscillators and regulators.

302 MODULATION/DEMODULATION, AND SIGNAL PROCESSING SYSTEMS (3) Two lecture hours and three lab hours per week. Prerequisite: E. T. 252 or equivalent qualifications. Study of the signal processing functions relative to modulation and demodulation of intelligence signals as used in audio and video communications systems.

310 DIGITAL LOGIC CIRCUITS II (3) Two lecture hours and three lab hours per week. Prerequisite: E. T. 260 or equivalent qualifications. A study of the application of basic logic circuits to digital functions such as counting, encoding/decoding, storing, computing, processing and controlling.

330 ELEC/MECH ASSEMBLY TECH II (2) One lecture hour and three lab hours per week. Prerequisite: Successful completion of E. T. 280 or equivalent industrial experience. Familiarization with industrial prototyping techniques. To provide instruction in printed circuit layout including artwork, photography and fabrication. (Extra supplies required).

350 ADVANCED CIRCUIT APPLICATIONS (4) Two lecture hours and six lab hours per week. Prerequisite: E. T. 300 or equivalent qualifications. Study of pulse and switching circuits, active radio-frequency circuits and advanced IC applications.

360 DIGITAL SYSTEMS (3) Two lecture hours and three lab hours per week. Prerequisite: E. T. 310 or equivalent qualifications. A study of electronic computing and control systems; the microprocessor, its interfaces and applications.

362 RADIO-FREQUENCY COMMUNICATION (4) Three lecture hours and three lab hours per week. Prerequisite: E. T. 302 or equivalent qualifications. Study of radio-frequency/microwave transmission, and reception principles and techniques, including transmission lines and antennas.

380 PRODUCT DEVELOPMENT (2) One lecture hour and three lab hours per week. Prerequisite: Successful completion of E. T. 280 and E. T. 330 or equivalent industrial experience. The student is acquainted with RF prototyping techniques and the various phases of product development and packaging. (Extra supplies required).

649 COOPERATIVE EDUCATION (1-4) (Credit/No Credit). Work experience in a field related to a career goal, supplemented by individual counseling from an instructor-coordinator.

666 CAREER EXPLORATION (1) Two lecture hours per week for the first eight weeks of the semester. Introduces students to the industrial field of electronics technology and provides guidance for academic planning in the preparation for future electronics employment.

680 SELECTED TOPICS IN ELECTRONICS TECHNOLOGY (1-3) Hours by arrangement. Selected topics in Electronics Technology not covered by regular catalog offerings. Course content and unit credit to be determined by the Technology Division in relation to community-student need and/or available staff. May be offered as a seminar, lecture or lecture/laboratory class.

690 SPECIAL PROJECTS (1-2) Hours by arrangement. Prerequisite: 3.0 GPA in subject field. Independent study in a specific field or topic, directed by an instructor and supervised by the Division Director. Students are eligible to request approval of a Special Project only after successfully completing at least two college-level courses in the subject field. (Note: Students normally may receive credit for only one Special Project per semester).

710 DC AND AC ELECTRONICS FUNDAMENTALS (4) Three lecture hours and three lab hours per week. Prerequisite: E. T. 110 or previous electronics experience. Theory and practice for advanced study in electronics technology. DC and AC circuit actions of various combinations of resistance, capacitance and inductance. (Extra supplies may be required).

720 ACTIVE CIRCUITS AND DEVICES (4) Three lecture hours and three lab hours per week. Prerequisite: E. T. 710. Theory and practice in the use of steady-state circuit action of active devices. Significant characteristics and corresponding circuits of solid state devices-resistors, capacitors and/or inductors. (Extra supplies may be required).

730 APPLIED LINEAR AMPLIFIER ANALYSIS (4) Three lecture hours and three lab hours per week. Prerequisite: E. T. 720. Analysis of circuits: Review of single stage transistor amplifiers and frequency response, multistage direct-coupled amplifiers, negative feedback and amplifiers, operational amplifiers (adders), multipliers, active filters, equalizer tone controls, and power amplifiers, complementary and quasi-complementary.

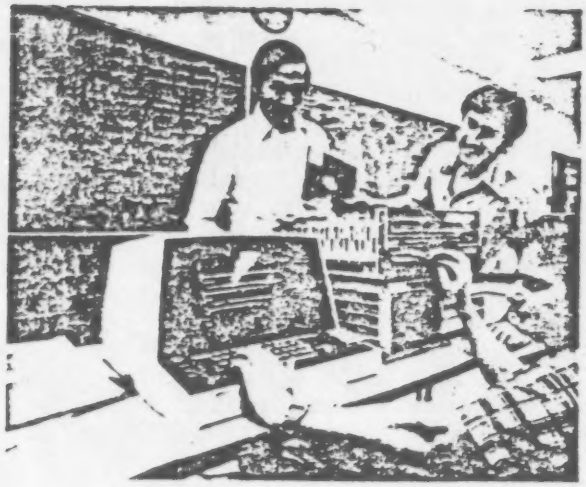
740 APPLIED ELECTRONICS CIRCUIT ANALYSIS (4) Three lecture hours and three lab hours per week. Prerequisite: E. T. 730. Analysis of circuits including power supplies, RF amplifiers, oscillators, non-sine waves and sine waves, FM-AM modulation and integrated circuit applications. (Extra supplies may be required).

760 MICROWAVE PRINCIPLES (3) Three lecture hours per week. Prerequisites: E. T. 730 or equivalent. Study of transmission lines, active and passive microwave devices and their applications that operate in the microwave region.

765 TELEVISION FUNDAMENTALS (4) Three lecture hours and three lab hours per week. Prerequisite: Two semesters of electronics or equivalent experience. Basic TV systems; modulation techniques and receivers, including CATV systems. Development of skills necessary for employment in electronic communication industries which require knowledge of TV systems. (Evening session only).

ELECTRONICS TECHNOLOGY

UTC at Provo/Orem
PO Box 1009 Provo, Utah 84601
(801) 224-6161



Associate Dean, School of Technology:
Rulon J. Wells. Office N205

Department Head: Don E. James. Office M 221. Electronic Technology Office M221

Instructors: James E. Barnes, Robert Fair, Kenneth J. Hacking, Chester Heath, Don E. James, Ralph Merrill, Robert H. Peterson, DeRay Shepherd, Jon Turner, William H. White.

OFFICES AND SHOPS LOCATED ON THE PROVO CAMPUS

Advisory Committee: Kent Amann - National Cash Register Company, Provo; Delbert Brown - Mountain Bell, Provo; Mark Hoyt - Auto Assay, Salt Lake City; Aage Olsen -Signetics Corporation, Orem; Kent Peay - IBM, Salt Lake City

Job Description

Electronic Technician

1. Know basically the atomic, chemical, and physical background concerning energy in its various forms, and its conversion in the production of direct and alternating current, voltage and electrical power; and the relationship of magnetic and electrostatic fields; resistance, reactance, impedance, electromechanical components, radio frequency radiation; etc. in the conversion process.

2. Work with resistors, capacitors, inductors, transformers, semi-conductors, tubes, relays, switches, hardware, and other electromechanical components of electrical and electronic circuits and equipment.

3. Be able to fabricate, conforming to industrial standards, electronic and electromechanical equipment, printed circuit boards and equipment containers, using basic hand tools and circuits and common shop equipment.

4. Understand the theory of, and can use rectifiers, filters, amplifiers, oscillators, modulators, detectors, wave-shaping circuits, stepping motors, syncros, control transformers, servos, magnetic amplifiers, and other circuits that when properly combined make up electronic and electromechanical equipment.

5. Understand the theory of, and use receivers, transmitters, display devices, micro processors, computers, and other equipment that when properly combined make up complete electronic and electromechanical systems.

6. Use ammeters, volt meters, and ohmmeters; resistance, capacitance, inductance, impedance, and other measurement bridges; audio and radio frequency generators; transistor and tube testers; oscilloscopes and oscillographs; and other commonly available electronic and electromechanical test equipment and test systems.

7. Coordinate all of his performance capabilities with the efforts of other members of a testing, production or research team.

8. Possess sufficient communication skills to effectively receive and transmit instructions, processes, ideas, and policies concerning his work and its relationship to others.

9. Understand sufficiently the economics, organizational structure, the various levels of work, and other related factors within the electronic industry so that he fits in harmoniously.

10. Possess proper personal characteristics to enable him to work harmoniously with his fellow technicians, engineers, scientists, supply people, supervisors, and other members of the total team.

If a student has not completed these prerequisites during his high school education, he may complete them at Utah Technical College at Provo. This may extend the length of his program beyond the normal six quarters. Transfer credit of equivalency examinations can be substituted for these courses.

Prerequisites for Electronic Technology

FIRST QUARTER

ET	101	D.C. Theory	(5:5:0)
ET	102	D.C. Problems	(2:1:4)
ET	103	D.C. Laboratory	(3:0:10)
ET	104	Math for Electricity	(5:5:0)
*HE	201	Occupational Safety	(2:2:0)
			17 credits
ET	195	VICA (Optional)	(1:1:0)

*See General-Related Education section of this catalog for course descriptions

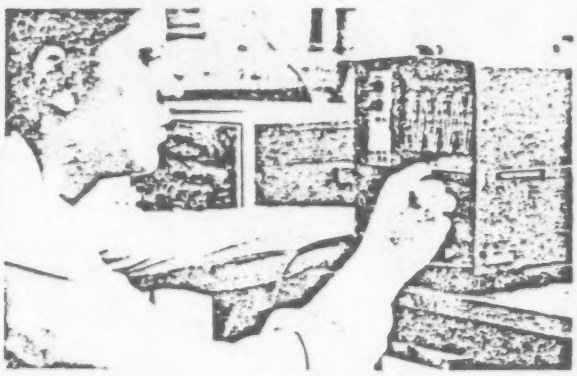
SECOND QUARTER

ET	105	A.C. Theory	(5:5:0)
ET	106	A.C. Problems	(2:1:4)
ET	107	A.C. Laboratory	(3:0:10)
ET	108	Math II for Electricity	(5:5:0)
*ENG	101	English Composition	(3:3:0)
			18 credits
ET	196	VICA (Optional)	(1:1:0)

Cooperative Education Courses

Cooperative education courses may be used in lieu of some of the laboratory or shop classes for completion of certification requirements. Approval of the departmental head must be secured prior to class enrollment.

Due to the specialized and technical requirements placed upon the electronics technician in industry, each student is strongly encouraged to earn the Associate in Applied Science Degree. Students who have complete most of the requirements for the Associate in Applied Science Degree (as listed below) but for justified reasons cannot complete all of these requirements, may petition for the issuance of a Certificate in Electronic Technology. In deserving instances, this certificate may be issued at the discretion of the instructional staff of the Electronic Technology Department with approval by the department head.



Requirements for the Associate in Applied Science Degree

FIRST QUARTER

ET	111	Semiconductor Theory	(5:0:0)
ET	112	Semiconductor Problems	(2:2:0)
ET	113	Semiconductor Laboratory	(5:0:15)
ET	114	Calculus for Electronics	(3:3:0)
*PSP	121	Technical Physics (Mechanics)	(5:5:0)
			20 credits
ET	195	VICA (Optional)	(1:1:0)

SECOND QUARTER

ET	121	Basic Circuit Theory	(5:5:0)
ET	122	Basic Circuit Problems	(2:2:0)
ET	123	Basic Circuit Laboratory	(5:0:15)
ET	124	Calculus II for Electronics	(3:3:0)
*PSP	122	Introductory Physics	(5:5:0)
			20 credits
ET	196	VICA (Optional)	(1:1:0)

THIRD QUARTER

ET	131	Circuit Applications Theory	(5:5:0)
ET	132	Circuit Applications Prob	(2:2:0)
ET	133	Circuit Applications Lab	(5:0:15)
ET	135	Digital Systems Fund	(3:2:3)
*HUE	107	Technical Writing	(3:3:0)
			18 credits
ET	196	VICA (Optional)	(1:1:0)

FOURTH QUARTER

ET	241	Pulse & Logic Circuits Theory	(5:5:0)
ET	242	Pulse & Logic Circuits Prob	(2:2:0)
ET	243	Pulse & Logic Circuits Lab	(5:0:15)
ET	245	P.C. Board Design & Fabrication	(3:2:3)
*SSPS	111	State & Local Government	(3:3:0)
			18 credits
ET	295	VICA (Optional)	(1:1:0)

FIFTH QUARTER

ET	251	Computer and Digital Systems	(5:5:0)
ET	252	Computer and Digital Prob	(2:2:0)
ET	253	Computer and Digital Systems Lab	(5:3:5)
ET	255	Digital Systems Projects	(5:3:5)
		*Elective	(3:3:0)
			17 credits
ET	296	VICA (Optional)	(1:1:0)

SIXTH QUARTER

ET	261	Communications Systems Theory	(5:5:0)
ET	262	Communications Systems Prob	(2:2:0)
ET	263	Communcations Systems Lab	(5:0:15)
ET	265	Communcations Systems Project	(5:3:5)
*SSP	100	Psychology of Human Relations	(3:3:0)
			20 credits
ET	297	VICA (Optional)	(1:1:0)

*See General-Related Education section of this catalog for course descriptions

Cooperative Education

Cooperative education courses may be used in lieu of some of the laboratory or shop classes for completion of certification requirements. Approval of the department head must be secured prior to class enrollment.

Courses included within this curriculum will be offered anytime need is demonstrated irrespective of quarter or time of day and in keeping with college regulations. Credit will be determined according to Unit Value statement printed elsewhere in this catalog.

The candidate for the Associate in Applied Science Degree (AAS) may substitute OCC 101 (Occupational Orientation) for ENG 101 (English Composition) and OCC 102 (Occupational Relations) for SSP 100 (Psychology of Human Relations). All other requirements for the AAS Degree as listed above and in the Student Information section of this catalog must be completed.

The numbers in parenthesis following a course title indicate the number of credits, lecture hours per week, and laboratory hours per week, in that order. (CR:LEC:LAB)

Course Descriptions

ET 101 Direct Current Theory .....(5:5:0)

The student studies basic physical concepts concerning electrical energy and its relation to other forms of energy, the electrical and physical characteristics of direct circuit components, basic direct current circuit configurations, direct current devices for measuring, and laws and theorems that facilitate circuit analysis. Examples of topics covered are structure of matter; current, voltage, resistance, conductance and power; series, parallel, combination and bridge circuits; ohmmeters, ammeters, and voltmeters; Ohm's, Watt's and Kirchoff's laws; superposition, Thevenin's, Norton's and maximum power transfer theorems; and basic electromechanical components.

ET 102 Direct Current Problems .....(2:1:4)

Assistance is given to the student in the solution of practical circuit problems and appropriate projects involving the concepts and theories of D.C. circuits.

ET 103 Direct Current Laboratory .....(3:0:10)

The student has hands-on experience in applying D.C. Circuit Theory to actual physical circuits. He learns the proper use of appropriate test equipment and hand tools. He gains proficiency in soldering and circuit construction. He learns correct laboratory procedure and the preparation of lab reports. Emphasis is placed on safety to personnel and equipment.

ET 104 Mathematics I for Electricity .....(5:5:0)

This course covers the necessary mathematical background to understand the theories, concepts, and laws as they apply to the circuit components and circuits covered in D.C. circuits theory. A brief review of algebraic rules is presented first, then such subjects as power of ten, reciprocals, ratio, and proportion, quadratic equations, simultaneous linear equations, cartesian coordinate graph system, and common logarithms.

ET 105 Alternating Current Theory .....(5:5:0)

This course covers the electrical characteristics of alternating current and voltage, the mathematical analysis and description of alternating current and voltage, the effects alternating current and voltage have on electrical and electromechanical components, the electrical and physical characteristics of alternating current circuit components, and characteristics and configurations of circuits to which alternating current is applied. Examples of topics included are inductance, capicitance, transformers, reactance, impedance, admittance, susceptance, power, vectors, resonance, filters, bandwidth, pads, attenuators, frequency, cycle, phase angle, amplitude, effective value, peak value, peak-to-peak value and average value.

ET 106 Alternating Current Problems .....(2:1:4)

Assistance is given to the student in the solution of practical circuit problems involving the concepts and theories of ET 105 and in related project work.

ET 107 Alternating Current Laboratory .....(3:0:10)

The student has hands-on experience in applying A.C. circuit theory to actual physical circuits. He learns the proper use of appropriate test equipment and hand tools. He gains additional experience with circuits, prints, and lab report preparation. Emphasis is placed on personnel and equipment.

ET 108 Mathematics II for Electricity .....(5:5:0)

This course covers the necessary mathematical background to understand the theories, concepts and laws as they apply to the circuit components and circuits covered in ET 105. A brief review of topics covered in math, ET 104, is presented first, then such topics as applied geometry, right angle trigonometry, law of cosines, natural logarithms, phasor algebra, logarithmic and exponential equations.

ET 111 Semiconductor Theory .....(5:5:0)

This course presents the physical and electrical characteristics of semi-conductor devices and their circuits. Special emphasis is placed upon semiconductors in their many forms as circuit parameters, and circuit analysis in order to determine relationship of voltages, intrinsic and extrinsic currents, and transistor equivalent circuits.

ET 112 Semiconductor Problems .....(2:2:0)

Instruction and assistance is offered in solving practical circuit problems and with appropriate projects associated with the semiconductor theory covered in course ET 111.

ET 113 Semiconductor Laboratory .....(5:0:15)

Experiments are planned, conducted, and analyzed so that application of theory to actual circuits is accomplished. Emphasis is placed on operation of test equipment, proper lab procedures, safety procedures, and preparation of lab reports.

ET 114 Calculus I for Electronics .....(3:3:0)

Calculus I for Electronics is a course which provides basic concepts of differential calculus oriented specifically towards the electronics field. Included are concepts relating to electrical theory of inductance, capacitance, differentiators, included voltage, and rates of change. A variety of calculus functions are performed. Problems include differentials, maxima-minimas, average rates, limits, and derivations in various levels of complexity.

ET 121 Basic Circuit Theory .....(5:5:0)

Analysis and design of semiconductor and vacuum tube circuitry is covered in this course. Consideration is given to practical requirements, coupling methods, feedback, frequency response, biasing, stabilization and use of data sheets in designing and analyzing a variety of voltage and power amplifiers, oscillators, rectifiers, etc.

ET 122 Basic Circuit Problems .....(2:2:0)

Instruction and problem-solving assistance is rendered to help students with practical circuit problems and projects associated with course ET 121.

ET 123 Basic Circuit Laboratory .....(5:0:15)

This course provides practical application for the theory of course ET 121. Experiments are performed to verify circuit designs and to become familiar with circuit operation. The operation and use of more advanced test equipment is taught.

ET 124 Calculus II for Electronics .....(3:3:0)

This course is a continuation of Calculus I for Electronics, and it is oriented towards electronics theory. Included are concepts related to voltage induction; integrating circuits; current, voltage, and power; integrating instruments; and angular speed and velocity as it relates to AC theory. Mathematical operations include basic integrals, definite integrals, angular velocity, angular acceleration, trigonometric function, logarithms, exponents, double integrals, partial derivatives, Fourier series, and introduction differential equations.

ET 131 Circuit Applications .....(5:5:0)

This course provides advanced theories and principles of electronics systems, both solid state and vacuum tube types. It includes principles relative to modulation, transmission, reception, distortion, amplification, and production of intelligence. Types of equipment studied include power supplies, voltage regulators, amplifiers, oscillators, modulators, detectors, antennas, and frequency multipliers as related to sound systems, recorders, electromechanical applications, receivers, transmitters, and test equipment.

ET 132 Circuit Applications Problems .....(2:2:0)

Assistance is rendered to students in solving problems and working with appropriate projects associated with course ET 131. Also sessions are held to help prepare the student to pass FCC License examinations.

ET 133 Circuit Applications Laboratory .....(5:0:15)

In this lab course the student assembles and thoroughly analyzes the operation of practical circuits and he begins to build more complete systems such as multistage amplifiers, radio receivers, transmitters, and other electronic and electromechanical equipment. Servicing trouble shooting techniques are learned and practiced.

ET 135 Digital Systems Fundamentals .....(3:2:3)

This course provides the student with a thorough understanding of basic logic design. Topics included are number systems, codes, Boolean algebra, truth tables, Venn diagrams, Karnaugh maps, basic logic components (gates, flip-flops, counters, registers, timers, etc.), and an introduction to machine language programming.

ET 241 Pulse and Logic Circuit Theory .....(5:5:0)

This course covers circuit analysis and design practices pertinent to pulse, switching, and timing circuitry (of a non-sinusoidal nature). Continually, reference is made to the application of these circuits to computers, television, test equipment, radar and other equipment where pulse and logic techniques are employed. Topics included are combinatorial and synchronous sequential logic design, pulse characteristics and wave shaping.

ET 242 Pulse and Logic Circuit Problems .....(2:2:0)

Assistance is given to students in solving circuit analysis and design problems and working with appropriate projects associated with course ET 241.

ET 243 Pulse and Logic Circuits Laboratory .....(5:0:15)

In this lab practical application is provided for the circuit analysis and design theory presented in ET 241. Particular emphasis is placed on the use of more advanced and sophisticated test equipment.

ET 245 P.C. Board Design and Fabrication .....(3:2:3)

This course covers drafting techniques associated with electronics and the processes to design and fabricate P.C. boards. Some of the topics covered are lettering, electronic symbols and schematics, pictorial and wiring diagrams, parts layout, photo masters, developing, etching, etc.

ET 251 Computers and Digital Systems .....(5:5:0)

This course covers the fundamental theory and operation of digital computers (mini's and micro's) and other digital systems. Topics included are input-output peripheral equipment, memory element, control elements, arithmetic elements, data transmittal systems, interfacing, digitized test equipment, diagnostic programming, computer control of processes, etc.

ET 252 Computers and Digital Systems Problems .....(2:2:0)

Assistance is given to students in solving circuit analysis and design problems and working projects growing out of course ET 251.

ET 253 Computers and Digital Systems Laboratory ....(5:0:15)

The student is given the opportunity to do practical testing, evaluation and design work on digital systems that were presented in ET 251. He receives experience in troubleshooting and servicing digital circuits and systems, and computer used for computations and process control.

ET 255 Digital Systems Projects .....(5:3:5)

This course will familiarize the student with the organization, instruction, set, and applications of several of the most popular microprocessors, the equipment and process they control. Special purpose LSI devices such as varts, FDC's, ROMS (PROMS & EPROMS) RAMS, Keyboard encoders, etc. used for interfacing in digital control systems will be covered. "Hands On" experience with these devices will be gained by the student in the lab, as he builds, programs and "debugs" his project.

ET 261 Communications Systems Theory .....(5:5:0)

This course provides training in theory and circuit analysis relating to electronic communications systems. Emphasis is placed on TV broadcast receivers and transmitters, radio communications, telemetry, radar, recording and playback systems, facsimile, public address equipment, closed circuit TV, stereo equipment, and other communication systems. Up-to-date circuits and devices are studied as they are related to the systems. Also, the operation and automatic control of remote communication systems are studied.

ET 262 Communications Systems Problems .....(2:2:0)

Assistance is rendered to students with practical problems and those working on projects that relate to the communications systems covered in ET 261. Also, help is given to enable students to pass FCC License examinations.

ET 263 Communications Systems Laboratory .....(5:0:15)

The student is given the opportunity to test and evaluate the operation of more advanced electronic systems. Also he receives experience in troubleshooting and servicing available systems. In the case of very large and complex systems, the student will study training devices specifically designed to represent systems or portions of systems.

ET 265 Communications Systems Project .....(3:2:3)

Provides the opportunity for students to develop creative design and troubleshooting capabilities concerning communication systems. Emphasis is placed on individual projects which will give the student experience closely related to actual situations found on the job in the communications field.

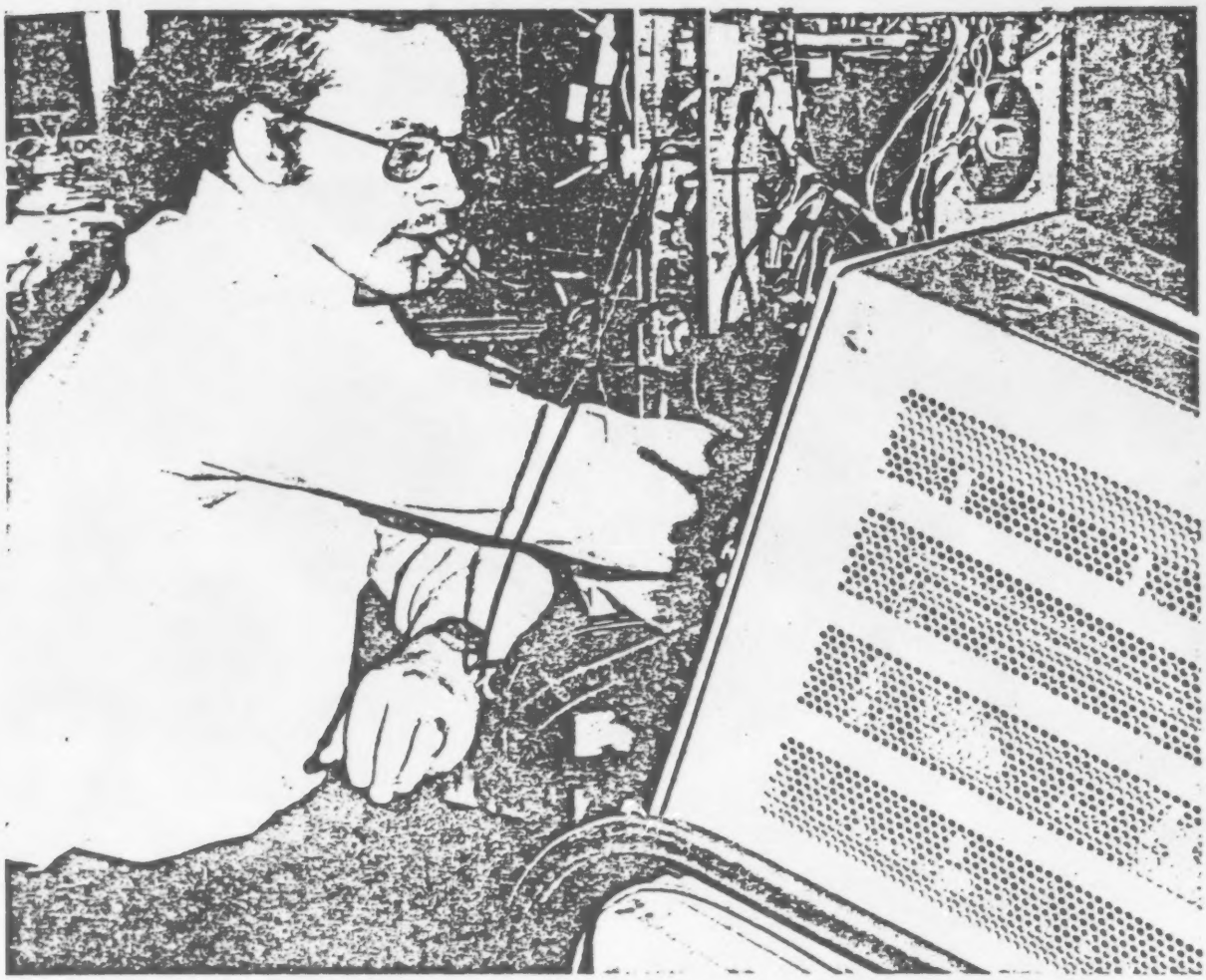
ET 281-2-3 Electronics Coop Education ..... 1 credit hr.

This class is designed to coordinate the work experience and meets at least once each week with an instructor. Work experience is discussed and related to the theory. Reports are shared by students in oral, written or demonstration form.

ET 285-6-7 ..... 1-5 credit hrs.

A report for each days work activity is necessary for a full five hours of credit. The credit given will be determined by the instructor and the student at the time of registration. 50 or more hours of work each quarter are required for each hour of credit granted. The instructor grants this credit when the work is completed, not necessarily coinciding with the end of the school quarter or term.

Classes must be taken in sequence ET 281-2-3 and ET 285-6-7. ET 281 must be taken with ET 285 and so on in sequence.



CHAPTER IV

ELECTRONIC INDUSTRIES

Personal visits were made to the following electronic companies:

Fairchild, Mountain View, California
Signetics, Sunnyvale, California
Advanced Technology Laboratories, Bellevue, Wa.
Physio-Control, Redmond, Wa.
Integrated Circuits Inc., Bellevue, Wa.
John Fluke Manufacturing, Everett, Wa.
Sundstrand Data Constrol, Redmond, Wa.

FAIRCHILD CAREER CENTER

A document concerning the Semiconductor Products Group Technician Training Program is included in this chapter. This document is for the use of operating managers and Industrial Relations personnel. It describes the program, its selection criteria, performance standards, responsibilities and summarizes the formal courses to be used.

PURPOSE:

The Semiconductor Products Group Technician Training Program is designed to provide guidance and assistance in the training of individuals for employment in a variety of specialty skill areas within the semiconductor group.

SCOPE:

The program is available to all departments within the Semiconductor Products Group and may be utilized to train present employees as well as individuals who may be recruited expressly for training as technicians.

DESIGN GOALS:

1. Utilize community educational resources.
2. Utilize accredited institutions.
3. Course work applicable toward degree attainment.
4. Courses coupled to FCI employment classifications.
5. Significant "on the job" training component.
6. Develop internal resources.
7. Utilize existing procedures for selection and administration.
8. Provide flexibility to accomodate fluctuating demand.

DEFINITION:

Job Families - The ten specific skill areas for which formal course training sequences have been specified.

In Family Jobs - Progressive job levels within a job family.

Education Steps - Formal course work specified as the minimum educational preparation for each job within a job family.

Technician Trainee - A new job combining "on the job" training with formal course work. Graded and compensated as a preparatory job to Assistant Technician for the appropriate job family and organization. Technician Trainee Requisitions will be posted and filled through existing JOS procedures. Technician Trainee positions allow flexible scheduling of formal class work with "on the job" training. A recommended schedule would allow 10 hours class work and 30 hours "on the job" work related training activities per week. Other combinations of class room work and "on the job" training activities are possible at the discretion of the hiring department.

Technician Scholarship- A program by which an individual may be paid at the present salary rate by the department granting the scholarship to attend formal course work during work hours up to a maximum of ten (10) hours per week as preparation for consideration for a Technician Trainee opening. Scholarships will be posted as requisitions and filled through existing JOS

procedures. While attending school on a Technician Scholarship the employee will continue to perform the present job for those hours (minimum 30 per week) while not attending classes. Technician Scholarships are granted for a six month period allowing completion of two quarters of part time course work (at ten class hours per week). Scholarships are designed for use in those instances in which an organization anticipates sufficient activity to support "on the job" training for a Technician Trainee in the future but cannot accomodate a full time Technician Trainee at the present time. Use of the scholarship allows selection and class room training in anticipation of later hiring the scholar as a full time Technician Trainee.

It is necessary for the scholarship granting department and the department currently employing the recipient to cooperate sufficiently to insure maximum productivity during the 30 hours per week devoted to present job responsibilities and to guarantee optimum utilization of the 10 hours per week of scholarship supported class work.

SELECTION:

Requisitions for Technician Trainee and Technician Scholarships will be posted at all Santa Clara Valley locations and open to bidding through the existing JOS procedure. Those Technician Trainee requisitions not filled through JOS would proceed to employment for external recruiting.

TECHNICIAN TRAINEE	TECHNICIAN SCHOLAR
* 6 Months Company Experience	* Suspend 6 Months Time-In-Grade Requirement For JOS Bid
* Satisfactory On The Job Performance	* Satisfactory On The Job Performance
* Demonstrated Successful Performance In Similiar Course Work & Acceptance By The Community College	* Acceptance By The Community College
* Mathematics Qualifying Exam, Foothill	* Mathematics Qualifying Exam, Foothill
* Possible Credit For Previous Relevant Course Work	

PERFORMANCE STANDARDS:

Technician Scholarship - Should a scholarship recipient not maintain a "C" grade average in all class work, the recipient will be dropped from the program and returned to the previous standard 40 hour per week work schedule in the present job. A scholar must maintain a "satisfactory" performance level in the existing job during the 30 hours per week while not in class. Failure to meet this standard may result in removal from the program.

Technician Trainee - The employing department may, at its discretion, establish scholarship, job performance, and job training standards for those Technician Trainees it employs. It is suggested that a minimum grade of "C" in all course work and a "satisfactory" work performance standard be maintained as minimum requirements.

Failure to uphold performance standards may, at the discretion of the employing department, result in removal from the program. Individuals dropped from the program may be reassigned through existing counseling procedures.

UPGRADING OF EXISTING STAFF:

It is conceivable that individual departments may wish to utilize portions of the program in development plans for existing employees. Classroom and work schedules may be arranged at the discretion of the supervisor and the employee to accomodate class room activities, homework and existing job duties. Nothing would prevent an employee from participating in the formal course work training program at the urging of the supervising department, either during work hours by special arrangement or during free time. Individuals are also encouraged to pursue the formal course work portion of the program either at the Career Center or off-site during free time on their own initiative in preparation for consideration for Technician Trainee openings or other Technician job openings.

RESPONSIBILITY FOR CHARGES:

Technician Scholar - The time during which the scholar is away from the job while involved in class room training the salary expense is charged to the department granting the scholarship. During the thirty hours per week in which the scholar performs the present job, salary expense is charged to the employing department. Should the scholarship granting department and the employing department not be the same, it will be necessary for the two departments to cooperate sufficiently to insure that the class room training hours are of optimum benefit and that the employee maintains satisfactory work performance in the present job. Tuition, laboratory, and book charges will be covered by the existing corporate educational aid policy. Ninety percent of the above charges will be reimbursed upon receipt of a "C" grade or better upon course completion.

Technician Trainee - All salary cost is borne by the employing department. Tuition, laboratory, and book charges are covered by the corporate account through existing educational aid policy as described in the previous section.

The Career Center, may at its discretion, underwrite the cost of maintaining on-site courses in those instances for which enrollment from Fairchild and the public does not satisfy the Foothill minimum class size requirements.

RESPONSIBILITIES BORNE BY PARTICIPATING DEPARTMENTS:

1. Anticipate and forecast need sufficiently far in advance to allow sufficient lead time for accomodation of the one year training cycle for Assistant Technicians.

2. Track scholars to insure smooth transition to Technician Trainee promotion and, if necessary, transfer.Individuals completing a six month scholarship are eligible for consideration for all Technician Trainee openings in any Santa Clara Valley Division.

3. Determine proper compensation and grading for the Technician Trainee job appropriate for the department and the job family in question.

4. Design meaningful "on the job" training activities for scheduling during the thirty hours per week work training component of the Technician Trainee job.

5. Cooperate with scholarship granting departments to allow scheduling of recipients work responsibilities in a manner which does not prevent ten hours per week class room participation or satisfactory job performance during 30 hour per week work schedule.

6. Determine appropriate schedules for classroom and work training of technicians beyond the Assistant Technician level provided by the Technician Scholarship and Technician Trainee position.

7. Develop appropriate scholarship and job performance standards for Technician Trainees employed.

8. Handle counseling and reassignment of Technician Trainee drop outs.

JOB FAMILIES:

1. SEMICONDUCTOR DEVICE TECHNOLOGY
2. SEMICONDUCTOR RELIABILITY AND QUALITY ASSURANCE
3. ELECTRONIC CIRCUITS AND SYSTEMS
4. VACUUM TECHNOLOGY
5. COMPUTER SYSTEMS TECHNOLOGY
6. SEMICONDUCTOR PROCESS TECHNOLOGY
7. WAFER FABRICATION QUALITY CONTROL
8. MECHANICAL TECHNOLOGY
9. COMPUTER AIDED IC MASK DESIGN
10. COMPUTER AIDED PC DESIGN

The following section contains a summary of the courses specified for each educational step for the above ten job families.

CORE COURSES

	COURSE	TITLE	UNITS
Assistant Tech	* Elec 51	D. C. Circuits	7
	* Math 71	Electronic Math I	5
Technician	* Elec 52	A. C. Circuits	7
	* Math 72	Electronic Math II	5
	* Eng 58	Electronic Drafting	4
Senior Tech	* Elec 53	Electronic Circuits	7
	* Elec 58	Digital Circuits	5
Assistant Eng	* Elec 65	Linear Circuits	5

The above courses are common to a number of job family course sequences and form the foundation upon which each specialty skill area is developed. In later sections any core course specified in a job family is preceded by an asterisk (*). The above core courses are all selected from the offerings of the Foothill Community College District, as are all courses specified in following sections except where specifically noted.

SEMICONDUCTOR DEVICE TECHNOLOGY

Assistant Electronic Tech	*	Elec 51	D. C. Circuits	7
	*	Math 71	Electronic Math I	5
		SP 50	Semiconductor Processing	4
				16
Electronic Technician	*	Elec 52	A. C. Circuits	7
	*	Math 72	Electronic Math II	5
	*	Eng 58	Electronic Drafting	4
		SP 51	Photomasking	4
				20
Senior Electronic Tech	*	Elec 53	Electronic Circuits	7
	*	Elec 58	Digital Circuits	5
		Eng 59	Microelectronic Packaging	4
		SP 53	Diffusion	4
				20
Assistant Eng	*	Elec 65	Linear Circuits	5
		SP 55	Deposition	4
		SP 62	Device Physics	4
		Elec 62	Linear IC's	3
				16

SEMICONDUCTOR RELIABILITY AND QUALITY ASSURANCE

Assistant Tech	*	Elec 51	D. C. Circuits	7
	*	Math 71	Electronic Math I	5
	D/F	QA 60	Introduction to QA	4
	D/F	QA 61	Introduction to Stat. QA	4
				20
Technician	*	Elec 52	A. C. Circuits	7
	*	Math 72	Electronic Math II	5
	D	QA 63	Statistical Concepts and Techniques	4
	D	QA 64	Total QA Concepts and Techniques	4
				20
Senior Tech	*	Elec 53	Electronic Circuits	7
	*	Elec 58	Digital Circuits	5
		Elec 90	Semiconductor Processing	3
	D	QA 65	Reliability Objectives	4
				19
Assistant Eng		Elec 62	Linear Integrated Circuits	5
	D	QA 75	Reliability Engineering	4
	D	QA 68	Principles of Electronic Testing	4
	D	QA 71	Quality Engineering	4
	D	Eng 353A	Reliability Physics	2
				19

Courses preceded by a "D" are offered only by the De Anza Community College District. The balance are Foothill courses. Those marked "D/F" are available from both colleges.

ELECTRONIC CIRCUITS AND SYSTEMS

		COURSE	TITLE	UNITS
Assistant Electronic Tech	*	Elec 51	D. C. Circuits	7
	*	Math 71	Electronic Math I	5
		Eng 1	Computer Applications	5
				17
Electronic Technician	*	Elec 52	A. C. Circuits	7
	*	Math 72	Electronic Math II	5
	*	Eng 58	Electronic Drafting	4
				16
Senior Electronic Tech	*	Elec 53	Electronic Circuits	7
	*	Elec 58	Digital Circuits	5
		Elec 62	Linear IC's	3
		Elec 90	Semiconductor Processing Survey	3
				18
Assistant Eng	*	Elec 65	ADV Semiconductor Circuits	5
		Elec 70	Microprocessor Systems	5
		Elec 62L	Linear IC Laboratory	1
		Elec 59	Digital Applications	5
				16

VACUUM TECHNOLOGY

		COURSE	TITLE	UNITS
Assistant Tech	*	Elec 51	D. C. Circuits	7
	*	Math 71	Electronic Math I	5
	S	Laser 165A	Vacuum Technology	4
				16
Technician	*	Elec 52	A. C. Circuits	7
	*	Math 72	Electronic Math II	5
	*	Eng 58	Electronic Drafting	4
	S	Laser 165B	Vacuum Technology	4
				20
Senior Tech	*	Elec 53	Electronic Circuits	7
	S	Laser 166A	Vacuum Systems	4
		SP 50	Introduction to Semiconductor Processing	3
				14
Assistant Eng		SP 55	Deposition	4
	S	Laser 166B	Vacuum Systems	4
		Chem 1A	General Chemistry	5
	S	Laser 112	Vacuum Techniques	4
				17

Courses preceded by an "S" are offered at San Jose City College only. The balance of the above courses are available at Foothill College.

COMPUTER SYSTEMS TECHNOLOGY

		COURSE	TITLE	UNITS
Assistant Electronic Tech	*	Elec 51	D. C. Circuits	7
	*	Math 71	Electronic Math I	5
		Eng 1	Computer Applications	5
				17
Electronic Technician	*	Elec 52	A. C. Circuits	7
	*	Math 72	Electronic Math II	5
	*	Eng 58	Electronic Drafting	4
		CST 57	Assembly Lang Programming	5
				21
Senior Electronic Tech	*	Elec 53	Electronic Circuits	7
	*	Elec 58	Digital Circuits	5
		CST 61	Diagnostic Programming	5
		CST 63	Peripheral Devices	5
				22
Assistant Tech	*	Elec 65	Linear Circuits	5
		Elec 9	Digital Applications	5
		Elec 70	Microprocessor Systems	5
		CST 65	Computer Architecture	2
				17

SEMICONDUCTOR PROCESSING TECHNOLOGY

	COURSE	TITLE	UNITS
Assistant Laboratory Tech	SP 50	Introduction to Semi-conductor Processing	3
	SP 51	Photomasking	4
	Math 60	Technical Mathematics	5
			12
Laboratory Tech	SP 53	Diffusion	4
	Elec 60	Fundamentals of Electronics	4
	Eng 1	Computer Applications	5
			13
Senior Laboratory Tech	SP 55	Deposition	4
	SP 62	Device Physics	4
			8
Assistant Engineer	D Eng 344A	Modern Optics	2
	SP 63	Wafer Fabrication	4
	SP 64	Advanced Technologies	4
			10

The courses preceded by a "D" are offered at De Anza college only. The balance are Foothill College Courses.

WAFER FABRICATION QUALITY CONTROL

	COURSE		TITLE	UNITS
Assistant Tech	SP	50	Introduction to Semiconductor Processing	3
	SP	51	Photomasking	4
	Math	60	Technical Mathematics	5
	D QA	60	Introduction to QA	4
				16
Technician	SP	53	Diffusion	4
	Elec	60	Fundamentals of Electronics	4
	Eng	1	Computer Applications	5
	D QA	61	Introduction to Statistical Quality Control	4
				17
Senior Tech	SP	55	Deposition	4
	SP	62	Device Physics	4
	D QA	63	Statistical Concepts and Techniques	4
	D QA	64	Total QA Concepts and Techniques	4
				16
Assistant Eng	SP	63	Wafer Fabrication	4
	SP	64	Advanced Technologies	4
	D QA	76	Quality Analysis	4
	D QA	62	Quality Control Applications	4
				16

The courses preceded by a "D" are offered at De Anza College only. The balance are Foothill College courses.

MECHANICAL TECHNOLOGY

	COURSE	TITLE	UNITS
Assistant Tech	D/F Eng 51A	Technical Drawing, I	4
	* Math 71	Electronic Math I	5
	D Eng 73A	Materials and Processes	6
			15
Technician	D/F Eng 51B	Technical Drawing, II	4
	* Math 72	Electronic Math II	5
	D Eng 73B	Materials and Processes	6
			15
Senior Tech	D Eng 51C	Design Drafting	5
	D/F Eng 71	Mechanics of Materials	5
	D Eng 75	Plastic Materials	3
	D Eng 344A	Modern Optics	2
			15
Assistant Eng	D Eng 54	Advanced Design Drawing	5
	D Eng 65	Tool Design	3
	D Eng 367A	Elements of Industrial Engineering	4
	D Eng 367B	Industrial Engineering Seminar	2
			14

All courses preceded by a "D" are offered at De Anza College only. Those labeled D/F are offered at both De Anza and Foothill Colleges. The balance are Foothill Courses.

COMPUTER AIDED PC BOARD DESIGN

	COURSE	TITLE	UNITS
Entry Level	Eng 1	Computer Applications	5
	Eng 51A	Technical Drawing	4
	Elec 60	Fundamentals of Electronics	4
	Eng 63A	Introduction to Computer Aided Design	4
			17
Intermediate Level	Eng 51B	Technical Drawing II	4
	Eng 58	Electronics Drafting	4
	Math 60	Technical Mathematics	5
	WV Elec 56B	Introduction to PC Board Construction	1
			14

Course preceded by a "WV" is offered at West Valley College only. The balance specified above are Foothill College courses.

COMPUTER AIDED IC MASK DESIGN

	COURSE	TITLE	UNITS
Layout Machine Operator	Eng 1	Computer Applications	5
	Eng 57	Engineering Drawing	3
	SP 50	Introduction to Semi-conductor Processing	3
	SP 51	Photomasking	4
			15
Mask Designer or Senior Layout Machine Operator	Math 60	Technical Mathematics	5
	Eng 63A	Introduction to Computer Aided Design	4
	SP 52A	Bipolar IC Layout	4
	SP 53	Diffusion	4
			17
Senior Mask Designer	Elec 60	Fundamentals of Electronics	4
	SP 52B	MOS IC Layout I	4
	Eng 58	Electronics Drafting	4
	SP 55	Deposition	4
			16
Mask Design Specialist	SP 62	Device Physics	4
	SP 63	Wafer Fabrication	4
	SP 64	Advanced Technologies	3
	SP 52C	MOS IC Layout II	4
			15

SEMICONDUCTOR PRODUCTS GROUP - TECHNICIAN TRAINING PROGRAM

FOOTHILL COLLEGE COURSES - FALL 1979 CAREER CENTER SCHEDULE

The following section contains course descriptions and schedules for those courses offered in the Career Center. Registration forms will be available in The Center office by August 20th.

ELECTRONICS 51: FUNDAMENTALS OF ELECTRONICS

7 Units

Prerequisites: Mathematics 71 (may be taken concurrently).
Five hours lecture, six hours laboratory.
Schedule: Class begins September 19, 1979 (12 weeks duration)
NOTE: This class will be given at two different times.
1) Monday/Wednesday/Friday 8:00-9:30 a.m. at the Center
Concurrent Lab to be held at Foothill on
Tuesday/Thursday 3:00-6:10 p.m. Instructor: Jacobson

2) Tuesday/Thursday 3:30-5:40 p.m. at the Center
Concurrent Lab to be held at Foothill on
Monday/Wednesday 3:30-6:40 p.m. Instructor: Stein

ENGINEERING 57: ENGINEERING DRAWING

3 Units

Two hours lecture, three hours laboratory.
Schedule: Class begins September 19, 1979 (12 weeks duration)
Tuesday/Thursday 2:30-4:40 p.m.
(The Center) Instructor: Kratzer

MATHEMATICS 60: TECHNICAL MATHEMATICS

5 Units

Prerequisite: A qualifying score on the counseling examination.
Five hours lecture.
Schedule: Class begins September 19, 1979 (12 weeks duration)
Monday/Wednesday 5:00-7:10 p.m.
(The Center) Instructor: Nakamura

MATHEMATICS 71: ELECTRONIC MATHEMATICS

5 Units

Prerequisites: Mathematics 81 and qualifying score in counseling examination. Strongly recommend that Electronics 51 be taken concurrently.
Five hours lecture.
Schedule: Class begins September 19, 1979 (12 weeks duration)
NOTE: This class will be given at two different times.
1. Monday through Friday 7:00-7:50 a.m. Instructor: Dong
2. Monday through Thursday 4:00-5:05 p.m. Instructor: Gobets

MATHEMATICS 200: STRUCTURE OF ARITHMETIC

4 Units

Four hours lecture.
Schedule: Class begins September 19, 1979 (12 weeks duration)
Tuesday/Thursday 5:30-7:10 p.m.
(The Center) Instructor: Rand

SEMICONDUCTOR PROCESSING 50: INTRODUCTION TO SEMICONDUCTOR PROCESSING
4 Units

Three hours lecture.
Schedule: Class begins September 19, 1979 (12 weeks duration)
Monday/Wednesday/Friday 4:30-5:20 p.m.
(The Center) Instructor: Brennan

SEMICONDUCTOR PROCESSING 53: DIFFUSION
4 Units

Prerequisite: Semiconductor Processing 50 (may be taken concurrently).
Three hours lecture, two hours lecture-laboratory.
Schedule: Class begins September 19, 1979 (12 weeks duration)
Monday/Wednesday 5:30-6:50 p.m. (The Center)
Concurrent Lab to be held at Foothill College on
Tuesdays 5:30-7:10 p.m. Instructor: Van Zant

The following Foothill College courses specified in the Technician Training Program are available at other community locations during the Fall quarter as noted below:

ELECTRONICS 60: BASIC ELECTRONICS (2 Sections)
Schedule: 1. Fridays 6:00 - 9:40 p.m.
Location: Mountain View Center, 1965 San Ramon (off Rengstorff), Mountain View, Room 8, Instructor: Mr. Mayeur

Schedule: 2. Tuesdays 6:00 - 9:40 p.m.
Location: Foothill Campus, Room P23

ENGINEERING 1: (1 Section)
Schedule: Thursdays 6:00 - 9:40 p.m.
Location: Foothill Campus, Room E25, Instructor: Mr. Howry

ENGINEERING 51A: (2 Sections)
Schedule: Tuesdays/Thursdays 6:00 - 10:00 p.m.
Location: Foothill Campus, Room E24

Schedule: Friday/Saturday Friday 6:00 - 10:20 p.m./ Saturday 8:00-12:20 a.m.
Location: Foothill Campus, Room E24

SEMICONDUCTOR PROCESSING 51: PHOTOMASKING (2 Sections)
Schedule: Tuesdays 5:15-7:55 p.m.
Location: National Semiconductor (Kifer & Semiconductor Dr. (off Lawrence) in Santa Clara. LAB: 5:15-6:55 p.m. Thurs., at Foothill in Room E1.

Schedule: Mondays 2:00 - 4:40 p.m.
Location: Hewlett Packard (Cupertino) 11000 N. Wolfe.
LAB: Wednesdays 2:00-4:10 p.m., at Foothill in Room E1.

SEMICONDUCTOR PROCESSING 55: DEPOSITION
Schedule: Mondays 5:30 - 8:10 p.m.
Location: Advanced Micro Devices, 920 De Guigne, Sunnyvale.
LAB: Wednesday 5:30-7:10 p.m., at Foothill in Room E1.

SIGNETICS

Signetics, founded in 1961, is a subsidiary of the U. S. Philips Corporation. It is the sixth largest U. S. semiconductor manufacturing company with sales of $368 million in 1980. While headquartered in Sunnyvale, California, it has thirteen thousand employees worldwide. We have included their position descriptions in this chapter to give an idea of what industry expects from various levels of technicians.

Signetics

POSITION DESCRIPTION

JOB TITLE: ELECTRONIC TECHNICIAN I JOB CODE: H26

SUMMARY: Under moderate supervision performs routine functions related to the development, test, checkout, fabrication, modification and assembly of electronic and electro-mechanical systems, circuitry and test equipment.

DUTIES:

1. Works from simple schematics, diagrams, sketches, layouts or verbal instructions.
2. Troubleshoots faulty equipment or systems and learns remedies.
3. Performs calibration checks on electronic equipment and instruments.
4. Builds or modifies simple sub-assemblies according to detailed documentation.
5. Conducts routine tests to monitor performance and reliability of electronic or electro-mechanical equipment or systems.
6. Works with small hand and machine tools.
7. Preforms other related duties as assigned.

EDUCATION/TRAINING: Usually requires one year post High School electronics training.

EXPERIENCE REQUIRED: TECHNICAL AA DEGREE OR EQUIVALENT EDUCATION
OR NO DEGREE BUT 1 1/2 YRS RELATED EXPERIENCE

PROMOTION TO: ELECTRONIC TECHNICIAN II

EFFECTIVE DATE: 2-24-75 ANALYST Boyce

SYNETICS

POSITION DESCRIPTION

JOB TITLE: ELECTRONIC TECHNICIAN II JOB CODE: L26

SUMMARY: Under general supervision performs complex functions related to the development, test, checkout, fabrication, modification and assembly of electronic and electro-mechanical systems, experimental circuitry, prototype models and specialised test equipment.

DUTIES:

1. Works from complex schematics, diagrams, engineer sketches, layouts or verbal instructions.
2. Troubleshoots and debugs assemblies, sub-assemblies and systems by determining cause and remedy for malfunction.
3. Calibrates electronic equipment and instruments.
4. Assists in designing prototypes and building or modifying special purpose test equipment.
5. Conducts complex tests for performance and reliability and does experimental testing to collect design data.
6. Works with small machine tools and testor diagnostic equipment.
7. Assist in the training of new technicans.
8. Performs other related duties as assigned.

EDUCATION/TRAINING: Usually requires A.A. degree in electronic or in-service technical training.

EXPERIENCE REQUIRED: TECHNICAL AA DEGREE OR EQUIVALENT EDUCATION
PLUS 1 1/2 yrs RELATED EXPERIENCE OR
NO DEGREE BUT 3 yrs RELATED WORK EXPERIENCE

PROMOTION TO: SENIOR ELECTRONIC TECHNICIAN

EFFECTIVE DATE: 2-24-75 ANALYST Boyce

SIGNETICS

POSITION DESCRIPTION

JOB TITLE: SENIOR ELECTRONIC TECHNICIAN JOB CODE: P26

SUMMARY: Under limited supervision performs a variety of complex function related to the development, test, checkout, fabrication, modification and assembly of electronic and electro-mechanical systems, experimental circuitry, prototype models and specialized test equipment.

DUTIES:

1. Works from complex schematics, diagrams, sketches, layouts or verbal instructions often requiring interpretation and application of comprehensive knowledge and practical understanding of electronic theory and principles.
2. Troubles shoots and repairs complex automated systems and test equipment.
3. Performs operational tests of systems and equipment to ensure conformance with product specification.
4. Improvises procedures and recommends modifications.
5. Devises test equipment to monitor performance and reliability of prototype models and system designs.
6. Provides training for lower level technicians and directs their work.
7. Performs other related duties as assigned.

EDUCATION/TRAINING: Usually requires A.A. degree in elecrronics or in-service training technical.

EXPERIENCE REQUIRED: TECHNICAL AA DEGREE OR EQUIVALENT EDUCATION PLUS 3 1/2 YRS RELATED WORK EXPERIENCE OR NO DEGREE BUT 5 1/2 YRS RELATED EXPERIENCE

PROMOTION TO: ELECTRONIC TECHNICAL SPECIALIST

EFFECTIVE DATE: 2-24-75 ANALYST Boyce

Signetics

POSITION DESCRIPTION

JOB TITLE: ELECTRONIC SPECIALIST JOB CODE: R26

SUMMARY: Under little or no supervision analyzes and resolves complex problems relating to development, test, checkout, fabrication, modification or assembly of electronic and electro-mechanical systems, experimental circuitry, prototype models or specialized test equipment.

DUTIES:

1. Works from complex data requiring interpretation and application of electronic theory and principles.
2. Coordinates repair and maintenance of complex automated system and test equipment.
3. Designs operational tests of systems and equipment to insure conformance with product specifications.
4. Performs major systems checkout documenting results and recommending improvements.
5. Directs and schedules work of lower level technicians and provides training as required.
6. Performs other related duties as assigned.

EDUCATION/TRAINING: Usually requires A.A. degree in electronics or in-service technical training.

EXPERIENCE REQUIRED: TECHNICAL AA DEGREE OR EQUIVALENT EDUCATION PLUS
5 1/2 YRS RELATED WORK EXPERIENCE OR
NO DEGREE BUT 8 YRS RELATED EXPERIENCE

PROMOTION TO: EXEMPT SUPERVISOR

EFFECTIVE DATE: 2-24-75 ANALYST Boyce

Signetics

POSITION DESCRIPTION

JOB TITLE: LABORATORY TECHNICIAN I JOB CODE: H28

SUMMARY: Under moderate supervision sets up and operates basic measuring and testing devices to test electronic or electro-mechanical systems or processes under experimental conditions.

DUTIES:

1. Sets up and operates basic lab apparatus for testing electronic or electro-mechanical equipment and systems.
2. Works from precise, predetermined criteria such as blueprints, drawings, diagrams or engineering instructions.
3. Calibrates, modifies or repairs basic laboratory equipment.
4. Makes stores purchases to maintain adequate supply levels.
5. Performs maintenance and general housekeeping duties.
6. Learns equipment fabrication, failure analysis, and data interpretation.
7. Performs other related duties as assigned.

EDUCATION/TRAINING:

EXPERIENCE REQUIRED: TECHNICAL AA DEGREE OR EQUIVALENT EDUCATION
OR NO DEGREE BUT 1 1/2 YRS RELATED EXPERIENCE

PROMOTION TO: LABORATORY TECHNICIAN II

EFFECTIVE DATE: 2-24-75 ANALYST Boyce

signatics

POSITION DESCRIPTION

JOB TITLE: LABORATORY TECHNICIAN II JOB CODE: L28

SUMMARY: Under general supervision fabricates, sets up and operates various measuring and testing devices to test and evaluate electronic or electro-mechanical systems or processes under experimental conditions.

DUTIES:

1. Fabricates, sets up and operates various lab apparatus for testing and evaluating electronic and electro-mechanical equipment or parts.
2. Must rely on practical experience and knowledge of electronic and electro-mechanical theory and principles to assist in development of prototype systems, experimental circuitry etc.
3. Works from engineering instructions, technical manuals diagrams etc. requiring basic interpretation.
4. Calibrates, aligns, modifies, or repairs laboratory equipment.
5. Evaluates and records data on performance and reliability of electronic or electro-mechanical systems.
6. Learns equipment and systems design and complex testing.
7. May perform failure analysis on parts, components or systems.
8. Performs other related duties as assigned.

EDUCATION/TRAINING: Usually requires A.A. degree in electronics or electro-mechanical discipline.

EXPERIENCE REQUIRED: TECHNICAL AA DEGREE OR EQUIVALENT EDUCATION PLUS 1 1/2 YRS RELATED WORK EXPERIENCE OR NO DEGREE BUT 3 YRS RELATED EXPERIENCE

PROMOTION TO: SENIOR LABORATORY TECHNICIAN

EFFECTIVE DATE: 2-24-75 ANALYST Boyce

SYNCOM

POSITION DESCRIPTION

JOB TITLE: SENIOR LABORATORY TECHNICIAN JOB CODE: P28

SUMMARY: Under limited supervision determines methods and sequence of operations to develop and test electronic or electro-mechanical systems and processes under experimental conditions.

DUTIES:

1. Lays out, fabricates and assembles developmental electronic or electro-mechanical systems, experimental circuitry or prototype models.
2. Assist in the design of equipment or devices and recommends modifications.
3. Works from engineering instructions, technical manuals and knowledge of electronics requiring interpretation of complex data.
4. Sets up complex apparatus to test devices and systems and to evaluate performance and reliability.
5. Determines methods to adjust, calibrate, modify, or repair circuitry or components.
6. Performs detailed failure analysis and report causes for malfunction.
7. Assists in training of lower level technicians.
8. Performs other related duties as assigned.

EDUCATION/TRAINING: Usually requires A.A. degree in electronics or electro-mechanical discipline.

EXPERIENCE REQUIRED: TECHNICAL AA DEGREE OR EQUIVALENT EDUCATION PLUS 3 1/2 YRS RELATED EXPERIENCE OR NO DEGREE BUT 5 1/2 YRS RELATED EXPERIENCE

PROMOTION TO: LABORATORY SPECIALIST

EFFECTIVE DATE: 2-24-75 ANALYST Boyce

SIGNETICS

POSITION DESCRIPTION

JOB TITLE: LABORATORY SPECIALIST JOB CODE: R28

SUMMARY: Under little or no supervision analyzes complex data to determine methods and procedures in order to develop and test new or prototype electronic or electro-mechanical systems and processes under experimental conditions.

DUTIES:

1. Directs the lay-out, fabrication, and assembly of developmental electronic or electro-mechanical systems, experimental circuitry or prototype models.
2. Assists in design of equipment or devices and recommends improvements.
3. Performs analyzes of complex data and summarizes in report form.
4. Coordinates the set up of complex apparatus to test devices and systems and to evaluate performance and reliability.
5. Assist engineers and scientists with difficult failure analysis and perpares reports.
6. Directs and schedules all laboratory work and insures an efficient flow through the area.
7. Provides training for lower level technicians.
8. Performs other related duties as assigned.

EDUCATION/TRAINING: Usually requires and A.A. degree in electronics or electron-mechanical discipline.

EXPERIENCE REQUIRED. TECHNICAL AA DEGREE OR EQUIVALENT EDUCATION PLUS 5 1/2 YRS RELATED EXPERIENCE OR NO DEGREE BUT 8 YRS RELATED EXPERIENCE

PROMOTION TO: EXEMPT SUPERVISOR

EFFECTIVE DATE: 2-24-75 ANALYST Boyce

SYMETICS

POSITION DESCRIPTION

JOB TITLE: CHARACTERIZATION TECHNICIAN I JOB CODE: H30

SUMMARY: Under moderate supervision learns to prepare auto-test equipment programs and to check out interface fixtures.

DUTIES:

1. Learns to interpret specification test data and to use product data books in order to understand logic functions and prepare auto-testor programs.
2. Learns to program auto-test equipment and to debug programs.
3. Following detailed specifications, schematics or diagrams checks out test fixture for proper construction and operation.
4. Performs other related duties as assigned.

EDUCATION/TRAINING: High School diploma or equivalent experience usually requires 1 year formal electronics training at post-high school level with emphasis on logic functions or programming..

EXPERIENCE REQUIRED: TECHNICAL AA DEGREE OR EQUIVALENT EDUCATION OR
NO DEGREE BUT 1 1/2 YRS RELATED EXPERIENCE

PROMOTION TO: CHARACTERIZATION TECHNICIAN II

EFFECTIVE DATE: 2-24-75 ANALYST Boyce

SIGNETICS

POSITION DESCRIPTION

JOB TITLE: CHARACTERIZATION TECHNICIAN II JOB CODE: L30

SUMMARY: Under limited supervision prepares auto-test equipment programs and checks out equipment interface fixtures.

DUTIES:

1. Reviews specifications to ensure test data is correct.
2. May acquire customer waivers, engineering change notices or specification changes before programs can be prepared.
3. Using specification data, product data books and knowledge of logic functions, writes programs for auto-test equipment.
4. Receives paper or magnetic tape program from data processing and runs programs on auto-test equipment.
5. Corrects program errors.
6. Checks out test fixtures for proper construction and operation in compliance with specifications, rough drawing or schematics.
7. Performs other related duties as assigned.

EDUCATION/TRAINING: Usually requires 1 year formal electronics training at post-high school level with emphasis on logic functions or programming.

EXPERIENCE REQUIRED: TECHNICAL AA DEGREE OR EQUIVALENT EDUCATION PLUS 1 1/2 YRS WORK EXPERIENCE OR NO DEGREE BUT 3 YRS RELATED EXPERIENCE

PROMOTION TO: SENIOR CHARACTERIZATION TECHNICIAN

EFFECTIVE DATE: 2-24-75 ANALYST Boyce

SIGNETICS

POSITION DESCRIPTION

JOB TITLE: SENIOR CHARACTERIZATION TECHNICIAN JOB CODE: E30

SUMMARY: Under little or no supervision prepares complex auto-test equipment programs and checks out equipment interface fixtures.

DUTIES:

1. Reviews specifications to ensure test data is correct.
2. May acquire customer waivers, engineering change notices or specification changes before programs can be prepared.
3. Using specification data, product data books and knowledge of logic functions, writes programs for auto-test equipment.
4. May operate computer to run cards and prepare paper or magnetic tape programs.
5. Runs program on auto-test equipment and corrects errors.
6. Checks out test fixtures for proper construction and operation.
7. Assists in training lower level techs and may direct their work.
8. Prepares data reports or summaries of tests performed and checks the work of lower level techs.
9. Performs other related duties as assigned.

EDUCATION/TRAINING: Usually requires A.A. degree in electronics with emphasis on electronic programming.

EXPERIENCE REQUIRED: 5-6 years experience in electronics with 3-4 years in Characterization Programming.

PROMOTION TO: CHARACTERIZATION ENGINEER

EFFECTIVE DATE: 2-24-75 ANALYST Boyce

TITLE: FIELD SERVICE TECHNICIAN II

DEPT/DIV. FIELD SERVICE/CARDIOVASCULAR

DESCRIPTION: Provides on-site maintenance and routine repair and calibration of Physio-Control products. Performs checkout and emergency repairs. Maintains information files on assigned areas of responsibility with emphasis on built-in devices.

REQUIREMENTS: Two years formal technical training or equivalent plus a minimum of 2 years related technical experience with emphasis on solid state, analog and digital circuitry. Must be able to write legibly and speak convincingly to customers. First class FCC license is desirable. Certified Bio-medical technician background required.

OPENINGS: INTERVIEWING MANAGER

Denver, Colorado (5/21/81) Bayer
Cherry Hill, NJ (4/29/81)
New York CIty, NY (4/3/81)
Boston, MA (6/15/81) S. Papp
San Antonio, TX (6/15/81) F. Harris
San Diego, CA (6/81) S. Carter

TITLE: DISTRICT SERVICE MANAGER

DEPT/DIV. WESTERN DISTRICT SERVICE, DALLAS REGIONAL OFFICE

DESCRIPTION: Responsible for the supervision, recruiting, training and development of the Field Service Technicians in this district. Directs and coordinates field service compliance with customer contract specifications. Deals directly with customers and executives on complaints and problems recommending modifications for product improvements. Maintains goodwill of customers and promotes the sale of company products.

REQUIREMENTS: Two years formal technical training or equivalent experience plus a minimum of four years related technical experience. Must have demonstrated proven leadership ability, organizational talent and good written and verbal communication skills. Must be able to travel extensively.

Ron Burden

TITLE: TECHNICAL SALES REPRESENTATIVE II

DEPT/DIV. FIELD SERVICE/CARDIOVASCULAR/SOUTHWEST DISTRICT

DESCRIPTION: Calls on hospitals to obtain preventive contracts on biomedical instrumentation. Performs equipment inventory and prepares monthly reports on contacts made. Attends sales conventions and reads trade journals to remain aware of competitors' developments.

REQUIREMENTS: Two years technical training or equivalent experience, plus a minimum of three years related technical experience and first class FCC license desirable. Must be able to travel and safely handle biomedical equipment. Should possess good organizational and human relations skills.

OPENINGS: INTERVIEWING MANAGER

Houston, TX (6/18/81) Bob Matthews

TITLE: REGIONAL SECRETARY

DEPT/DIV. TECHNICAL SERVICES/CENTRAL REGION

DESCRIPTION: Secretarial and administrative support to the Regional Manager. Some of the duties will include typing all correspondence, memos, reports, plans, maintenance of data logs, travel arrangements and phone/mail coverage. Must be able to handle confidential information.

REQUIREMENTS: Must have capability to type 60-70 wpm, use 10 key calculator and transcribe from tapes. Ability to demonstrate self-confidence and good communication skills both verbal and written.

OPENINGS: INTERVIEWING MANAGER

Atlanta, GA (6/18/81) R. Stewart

ADVANCED TECHNOLOGY LABORATORIES, INC.

ATL began as an entrepeneurial venture in 1969 when a group of consulting engineers began to develop marine sonar systems. Then in 1974, through an association with the University of Washington, ATL introduced its first ultrasound system, which measured the characteristics of blood flow in the heart and other organs. Later, after pioneering discoveries in visualization of the heart, ATL introduced equipment that translates the echoes from ultrasound wave into moving, visual displays of the actual tissue and organs.

ATL JOB DESCRIPTION

POSITION TITLE: Engineering Technician I

REPORTING TO: Senior Level Technician

PAY STATUS: Non-Exempt

SUMMARY: This is technical work which is moderate in nature providing design and development support to the engineering department. Work may include general understanding of basic process techniques, associated instruments and equipment. Assists in the design and/or constructs instruments, circuits, mechanical assemblies or equipment for special applications (i.e., image procesor, interface boards, breadboards, etc.), and is responsible for test and proper operation. Makes drawings of sufficient quality for use by others. Sts up experiments, tests, or processes, under close supervision, and instructions on the approach and general plan. May set up and make operational a measuring system for a variety of electrical tests for a breadboard or prototype instrument or sub-assembly. May troubleshoot and repair basic equipment malfunctions. Responsible for process sheets or other documentation. Works under close supervision of a senior level technician or higher engineering classification. Errors in judgment should be immediately directed having minor impact on operations.

SCOPE OF RESPONSIBLITIES: Uses basic theoretical understanding of instruments, systems, and circuits in order to perform basic troubleshooting, calibration, and repair work. Performs routine testing from board to component, from instrument to sub-assembly, from system to instrument interfaces computers with peripherals. Records and maintains test data on instruments and subassemblies. Makes adjustments or change in equipment to produce specified quality and yield. Uses manufacturing and test documentation to build and test subassemblies. Assignments are specifically defined with instructions governing approach, methodology and results expected. Assignments of greater complexity and difficulty than normally given may be made where technical guidance and direction is given by a technician of higher classification or engineers. Performance is closely monitored and checked in detail necessary depending upon progressively demonstrated ability.

GENERAL DUTIES:

- Assist engineers in fabricating and assembling electronic subassemblies for prototype models from schematics, rough sketches and verbal instructions.
- Performs calibration checks on electronic instruments, troubleshooting electrinic systems to determine cause and remedy for malfunction.
- Conducts routine engineering tests and experimental testing.
- Solves mechnical or electronic problems involved in the operation of prctical electronic theory and basic tools as well as working from schematics and rough sketches in completing assignments.
- Assists in the preparation of design approach and test planning.
- Assists in the preparation of prototype drawings and the maintenance of redline drawings.
- Prepare and maintain assigned engineering notebooks.
- Prepare test reports for engineering evaluation.
- May be required to assist in the disposition of manufacturing problems.

MINIMUM QUALIFICATIONS: Two-year electronics degree or equivalent and basic exposure to engineering lab work. Directly related experience may be substituted on a year for year basis for the desired college training.

The statements contained herein reflect general details necessary to describe the principal functions of the job, the level of knowledge and skill typically required, and the scope of responsibility, but should not be considered an all-inclusive listing of work requirements. Individuals may perform other duties as assigned including work in other functional areas to cover absences or relief, to equalize peak work periods or to otherwise balance the work load.

6/2/80

EMPLOYEE _____

SUPERVISOR _____

COMPENSATION/
BENEFITS MANAGER _____

ATL JOB DESCRIPTION

POSITION TITLE: Engineering Technician II

PAY STATUS: Non-Exempt

SUMMARY: This is technical work of complex nature providing design and development support to the engineering department. Work may require the application of basic process techniques, associated instruments and equipment. Assists in the design and/or constructs instruments, circuits, mechanical assemblies or equipment for special applications (i.e., image processor, interface boards, breadboards, etc.), and is responsible for tests or processes, under intermittent supervision and instruction on the approach and general plan. Set up and make operational a measuring system for a variety of electrical tests for a breadboard or prototype instrument or sub-assembly. Troubleshoot and repair basic equipment malfunctions. Responsible for process sheets or other documentation. Works under moderate supervision of a senior level technician or higher level engineering classification. Errors in performance should be detected prior to having any major impact.

SCOPE OF RESPONSIBLITIES: Uses a thorough understanding of basic theoretical understanding of instruments, systems and circuits in order to perform troubleshooting, calibration and repair work. Performs moderately complex testing from board to components, from instrument to sub-assembly, from system to instrument and interfaces computers with peripherals. Records and maintains test data on instruments and subassemblies. Makes adjustments or changes in equipment to produce specified quality and yield. Uses manufacturing and test documentation to build and test subassemblies. Assignments, instructions governing approach and methodology are generalized where as expected results are well defined. Assignments of greater complexity and difficulty are completed with technical guidance and direction of a technician of higher level or engineers. Performance is reviewed as necessary depending upon complexity of work.

GENERAL DUTIES:

- Assist engineers in fabricating and assembling electronic subassemblies for prototype models from schematics, rough sketches and verbal instructions.
- Performs calibration checks on electronic instruments, troubleshooting electronic systems to determine cause and remedy for malfunction.
- Conducts routine engineering tests and experimental testing.
- Solves mechanical or electronic problems involved in the operation of the product.
- Assists in the preparation of design approach and test planning.
- Assists in the preparation of prototype drawings and the maintenance of redline drawings.
- Prepare and maintain assigned engineering notebooks.
- Prepare test reports for engineering evaluation.
- May be required to assist in the disposition of manufacturing problems.

MINIMUM QUALIFICATIONS: Two year electronics degree and two years of technician experience. Related experience may be substituted on a year per year basis for the required college training.

The statements contained herein reflect general details necessary to describe the principal functions of the job, the level of knowledge and skill typically required, and the scope of responsibility, but should not be considered an all-inclusive listing of work requirements. Individuals may perform other duties as assigned including work in other functional areas to cover absences or relief, to equalize peak work periods or to otherwise balance the work load.

8/20/80

EMPLOYEE _____

SUPERVISOR _____

COMPENSATION/
BENEFITS MANAGER _____

ATL JOB DESCRIPTION

POSITION TITLE: Engineering Technician III

PAY STATUS: Exempt

SUMMARY: This is technical work of a highly complex nature and versatility providing design and development support to the engineering department. Work requires thorough knowledge and application of process techniques, associated instruments and equipment. Assists in the design and/or construction instruments, circuits, mechanical assemblies or equipment for special application (i.e., image processor, interface boards, breadboards, etc.) and is responsible for test or processes under minimal supervision or instruction on the approach or general plan. Set up and make operational a measuring system for a variety of electrical tests for a breadboard or prototype instrument or sub-assembly. Troubleshoot and repair a broad scope of equipment malfunctions. Responsible for process sheets or other documentation. Works under occasional supervision of a higher level engineering classification. Errors in performance would typically be detected prior to having any major impact.

SCOPE OF RESPONSIBLITIES: Uses a thorough understanding of a broad scope of theoretical understanding of instruments, systems and circuits in order to perform extensive troubleshooting, calibration and repair work. Performs complex testing from board to component, from instrument to sub-assembly, from system to instrument and interfaces computers with peripherals. Records and maintains test data on instruments and subassemblies. Make adjustments or changes on equipment to produce specified quality and yield. Uses manufacturing and test documentation to build and test subassemblies. Assignments, instructions, governing approach and methodology for expected results are general and rarely specific. Performance is reviewed as necessary depending upon complexity of work.

GENERAL DUTIES:

- Assist engineers in fabricating and assembling electronic subassemblies for prototype models from schematics, rough sketches and verbal instructions.
- Performs calibration checks on electronic instruments, troubleshooting electronic systems to determine cause and remedy for malfunction.

GENERAL DUTIES: (Continued)

- Conducts broad scope of highly complex engineering tests and experimental testing.
- Solves mechanical or electronic problems involved in the operation of electronic theory and standard or specialized tools as well as working from schematics and rough sketches in completing assignments.
- Assists in the preparation of design approach and test planning.
- Assists in the preparation of prototype drawings and the maintenance of redline drawings.
- Prepare and maintain assigned engineering notebooks.
- Prepare test reports for engineering evaluation.
- May be required to assist in the disposition of manufacturing problems.

MINIMUM QUALIFICATIONS: Two-year electronic degree and five years of technician experience. Directly related experience may be substituted on a year for year basis.

The statements contained herein reflect general details necessary to describe the principal functions of the job, the level of knowledge and skill typically required, and the scope of responsibility, but should not be considered an all-inclusive listing of work requirements. Individuals may perform other duties as assigned including work in other functional areas to cover absences or relief, to equalize peak work periods or to otherwise balance the work load.

8/20/80

EMPLOYEE _____

SUPERVISOR _____

COMPENSATION/
BENEFITS MANAGER _____

ATL JOB DESCRIPTION

POSITION TITLE: Test Technician I

PAY STATUS: Non-Exempt

SUMMARY: Perform moderately complex test related activities on electronic and mechanical components, subassemblies and assemblies. Test, troubleshoot, calibrate, align and repair a complete variety of electrical, electronic and mechanical components, subassemblies and assemblies prior to and subsequent to quality control inspection and final shipping. Work is performed in accordance with established procedures, practices, standards and specificaitons and with the use of engineering prints, drawing, diagrams, schematics, and regular and special electronic test equipment.

SCOPE OF RESPONSIBLITIES: Under intermittent supervision, perform testing, troubleshooting and repairing tasks of moderate complexity. Operate from specific and definite directions using established and well known procedures, but with some judgement and interpretation required in application. Position involves regular, routine, recurring and moderately complex work situations, and the majority of work is verified by another person. Normally works with immediate supervisors only, but may interface with Engineering Department where necessary. Errors in work could create some loss of funds, accounts, cause delays or affect Company image. Receives no instruction on regular work, but may work under close direction to learn more complex operations.

GENERAL DUTIES:

- Test, troubleshoot, calibrate, align and repair a complete variety of electrical, electronic and mechanical components, subassemblies and assemblies to include printed circuit boards, mainframes, end items and all final assemblies prior to and subsequent to quality control inspection and final shipping.

- Operate a wide variety of electronic equipment including oscilloscope, digital multimeter, frequency counter, signal generator, phase meter, digital voltmeter, frequency generator, and other miscellaneous hand tools including soldering iron.

GENERAL DUTIES (continued)

- Read, interpret and implement verbal and/or written instructions, requirements, procedures and specifications in relation to the task to be performed.
- Set up test fixtures in accordance with established procedures.
- Initial REA's to correct design or manufacturing errors or discrepancies using existing documentation and personal working knowledge.
- Perform other related duties of similar complexity as assigned.

MINIMUM QUALIFICATIONS:

Full working knowledge of electrical, electronic and mechanical component testing, troubleshooting and repairing techniques. Thorough understanding of engineering prints, diagrams, specifications and schematics. Ability to understand and implement verbal and/or written instructions. Ability to relate and communicate both intradepartmentally and interdepartmentally. Ability to work independently. Manual dexterity and manipulative skills and ability necessary to perform preceding typical duties. Good vision and color perception due to close and exacting work.

AA Degree in Electronics or equivalent background to include course work in analog and digital theory, circuitry and repair techniques, standard electronic measuring equipment or practical, on-the-job testing, troubleshooting and repairing of electronic equipment experience desirable.

Directly related experience may be substituted on a year-per-year basis for the required college training.

The statements contained herein reflect general details necessary to describe the principal functions of the job, the level of knowledge and skill typically required, and the scope of responsibility, but should not be considered an all-inclusive listing of work requirements. Individuals may perform other duties as assigned including work in other functional areas to cover absences or relief, to equalize peak work periods or to otherwise balance the work load.

5/9/80

EMPLOYEE _____

SUPERVISOR _____

COMPENSATION/
BENEFITS MANAGER _____

ATL JOB DESCRIPTION

POSITION TITLE: Test Technician II

PAY STATUS: Non-Exempt

SUMMARY: Perform moderately complex test related activities on electronic and mechanical components, subassemblies and assemblies. Test, troubleshoot, calibrate, align and repair a complete variety of electrical, electronic and mechanical components, subassemblies and assemblies prior to and subsequent to quality control inspection and final shipping. Work is performed in accordance with established procedures, practices, standards and specifications and with the use of engineering prints, diagrams, schematics and other specifications and regular and special electronic test equipment.

SCOPE OF RESPONSIBLITIES: Under intermittent supervision, perform testing, troubleshooting and repairing tasks of moderate complexity. Operate from specific and definite directions using established and well known procedures but with some judgement and interpretation required in application. Position involves regular, routine, recurring and mocerately complex work situations, and the majority of work is verified by another person. Normally worked with test lead and supervisors only, but may interface with Engineering Department where necessary. Errors in work could create some loss of funds, accounts, cause delays or affect Company image. Receives no instruction on regular work, but may work under close direction to learn more complex operations.

GENERAL DUTIES:

- Test, troubleshoot, calibrate, align and repair a complete variety of electrical, electronic and mechanical components, subassemblies and assemblies, to include printed circuit boards, mainframes, end items and all final assemblies prior to quality control inspection and final shipping.
- Operate a wide variety of electronic equipment including oscilloscope, digital multimeter, frequency generator, and other miscellaneous hand tools including the soldering iron.
- Read, interpret and implement verbal and/or written instructions, requirements, procedures and specifications in relation to the task to be performed.

GENERAL DUTIES:
(continued)

- Set up test fixtures in accordance with established procedures.
- Initiate REA's to correct design or manufacturing errors or discrepancies using existing documentation and personal working knowledge.
- Train and/or assist employees of subordinate classifications in testing, troubleshooting and repairing techniques, procedures and practices as directed.
- Perform other related duties of similar complexity as assigned.

MINIMUM QUALIFICATIONS:

Full working knowledge of electrical, electronic and mechanical component testing, troubleshooting and repairing techniques. Thorough understanding of engineering prints, diagrams, specifications and schematics. Ability to understand and implement verbal and/or written instructions. Ability to relate and communicate both intradepartmentally and interdepartmentally. Ability to work independently. Manual dexterity and manipulative skills and ability necessary to perform preceding typical duties. Good vision and color perception necessary due to close and exacting work. Ability to instruct technicians of other classifications. Six months to two years experience as a Test Technician I or equivalent. Two year (AA) Degree in electronics to include course work in analog and digital theory, circuitry and repair techniques, standard electronic measuring equipment or practical, on-the-job testing, troubleshooting and repair of electronic equipment experience desirable.

Directly related experience may be substituted on a year-per-year basis for the required college training.

The statements contained herein reflect general details necessary to describe the principal functions of the job, the level of knowledge and skill typically required, and the scope of responsibility, but should not be considered an all-inclusive listing of work requirements. Individuals may perform other duties as assigned including work in other functional areas to cover absences or relief, to equalize peak work periods or to otherwise balance the work load.

5/9/80

EMPLOYEE _____

SUPERVISOR _____

COMPENSATION/
BENEFITS MANAGER _____

ATL JOB DESCRIPTION

POSITION TITLE: Test Technician III

PAY STATUS: Non-Exempt

SUMMARY: Perform moderately complex to complex test related activities on electronic and mechanical components, subassemblies and assemblies. Test, troubleshoot, calibrate, align and repair a complete variety of electrical, electronic and mechanical components, subassemblies and assemblies prior to and subsequent to quality control inspection and final shipping. Work is performed in accordance with established procedures, practices, standards and specifications and with the use of engineering prints, diagrams, schematics and other specifications and regular and special electronic test equipment.

SCOPE OF RESPONSIBLITIES: Under infrequent and general supervision, regularly and independently perform new, complex and difficult test-related assignments. Work is performed in accordance with general policies and procedures, but with considerable latitude, judgement and interpretation required in application. Work is only checked by review of overall results against particular standards and objectives. Errors in work could result in disruption and delay of operations and increased expenditure of Company funds. Individual normally works with immediate associates, test lead and supervisors only, but may inteface with Engineering Department where necessary. Receives no instruction on routine work and infrequent direction on new assignments.

GENERAL DUTIES:

- Test, troubleshoot, calibrate, align and repair the more complex electronic, electro-mechanical and mechanical components, subassemblies and assemblies, to include printed circuit boards, mainframes, end items and all final assemblies prior to quality control inspection and final shipping.

- Train technicians of subordinate classifications in all testing, troubleshooting and repairing techniques, procedures and practices as directed.

GENERAL DUTIES: (continued)

- Operate a variety of electronic equipment including oscilloscope, digital multimeter, frequency generator, and other miscellaneous hand tools including the soldering iron.
- Read, interpret and implement verbal and/or written instructions, requirements, procedures and specifications in relation to the task to be performed.
- Set up test fixtures in accordance with established procedures.
- Initiate REA's to correct design or manufacturing errors or discrepancies using existing documentation and personal working knowledge.
- Perform other related duties of similar complexity as assigned.

MINIMUM QUALIFICATIONS:

Thorough knowledge and understanding of electrical, electronic and mechanical component testing, troubleshooting and repairing techniques. Thorough understanding of engineering prints, diagrams, specifications and schematics. Ability to understand and implement verbal and/or written instructions. Ability to relate and communicate both intradepartmentally and interdepartmentally. Ability to work independently. Manual dexterity and manipulative skills and ability necessary to perform preceeding typical duties. Good vision and color perception necessary due to close and exacting work. Ability to instruct technicians of subordinate classifications. One to two years experience as a Test Technician II or equivalent.

Two year (AA) Degree in electronics to include course work in analog and digital theory, circuitry and repair techniques, standard electronic measuring equipment or practical, on-the-job testing, troubleshooting and repair of electronic equipment experience desirable.

Directly related experience may be substituted on a year-per-year basis for the required college training.

The statements contained herein reflect general details necessary to describe the principal functions of the job, the level of knowledge and skill typically required, and the scope of responsibility, but should not be considered an all-inclusive listing of work requirements. Individuals may perform other duties as assigned including work in other functional areas to cover absences or relief, to equalize peak work periods or to otherwise balance the work load.

5/9/80

EMPLOYEE _____

SUPERVISOR _____

COMPENSATION/
BENEFITS MANAGER _____

ATL JOB DESCRIPTION

POSITION TITLE: Test Technician, (IV)

PAY STATUS: Non-Exempt

SUMMARY: This is responsible, supervisory work organizing and directing the work of lower level technicians in the equipment testing area. Act as management representative and liaison between the test technicians and management.

SCOPE OF RESPONSIBLITIES: Work is performed under the general direction and supervision of a higher level administrative person. Accuracy and timeliness are imperative, failure to meet schedules and demands of the position could cause equipment failure or late shipments costing the Company revenue.

GENERAL DUTIES:

- Proper utilization of skills, space and equipment in accomplishing schedule requirements.
- Provide guidance and training to assigned personnel.
- Work with Supervision and Inspection to minimize errors and define problem areas.
- Assure that all customer return items are rebuilt and/or processed to drawings, specifications, plans and procedures, including retrofits.
- Promptly inform Supervision and Management of all situations resulting in slow-down or work stoppages.
- Work with Production Control to stage all work orders, materials and supplies, for customer upgrades.
- Ensure that all assigned personnel are at their work stations and working during work hours.
- Assist in performance evaluations as required by Supervision.
- Reprimand and discipline lower level test technicians.
- Maintain a neat, orderly, clean and safe work area.
- Enforce safety rules and company regulations as delegated by Supervision.

GENERAL DUTIES: (Continued)

- Assist in flow studies and new product releases and program implementation.
- Assist Engineering and Marketing in re-design, modifications and initiate planning of DCR's, procedures in preparation for production release to Manufacturing.
- Select, hire and train lower level test technicians.
- Other related duties as assigned.

MINIMUM QUALIFICATIONS:

AA degree in electronics. Two to three years test technician experience.

Directly related experience may be substituted on a year-per-year basis for the required college training.

The statements contained herein reflect general details necessary to describe the principal functions of the job, the level of knowledge and skill typically required, and the scope of responsibility, but should not be considered an all-inclusive listing of work requirements. Individuals may perform other duties as assigned including work in other functional areas to cover absences or relief, to equalize peak work periods or to otherwise balance the work load.

5/9/80

EMPLOYEE _____

SUPERVISOR _____

COMPENSATION/
BENEFITS MANAGER _____

ATL JOB DESCRIPTION

POSITION TITLE: Technical Service Representative I

REPORTING TO: Regional Service Manager

PAY STATUS: Non-Exempt

SUMMARY: Performs basic technical work in providing professional service and training to ATL customers, troubleshoots and repairs ATL systems and equipment in a trainee capacity. Duties may include troubleshooting and repairing of customer-owned ATL equipment; install and repair systems; maintain customer files for assigned area; serve as a liaison between the field and technical support group; sell maintenance agreements.

SCOPE OF RESPONSIBLITIES: The incumbent assigned to this position performs basic technical work in a trainee capacity. Detailed instruction is normally received. Work is performed under the direct supervision of the Regional Service Manager.

GENERAL DUTIES: Performs one or more of the following tasks in a trainee capacity.

- Provide professional service and training to ATL customers.
- Provide customer engineering of approved changes required for specific installations.
- Performs basic troubleshooting and repairing of customer-owned ATL equipment.
- Install systems as required.
- Maintain Customer Service files for an assigned area.
- Provides assistance to sales force.
- Maintain company expense account and equipment issued to perform field service.
- Provide professional liaison between the field and Technical Support Group on technical matters.
- Maintain an inventory of spare parts.
- Selling of maintenance agreements.
- Perform other specific or general tasks as assigned.

MINIMUM QUALIFICATIONS:	AA degree in electronics or equivalent and two years previous experience in troubleshooting analog and digital circuits.
	Requires extensive car and/or air travel.

The statements contained herein reflect general details necessary to describe the principal functions of the job, the level of knowledge and skill typically required, and the scope of responsibility, but should not be considered an all-inclusive listing of work requirements. Individuals may perform other duties as assigned including work in other functional areas to cover absences or relief, to equalize peak work periods or to otherwise balance the work load.

5/16/80

EMPLOYEE _____

SUPERVISOR _____

COMPENSATION/
BENEFITS MANAGER _____

ATL JOB DESCRIPTION

POSITION TITLE: Technical Service Representative II

REPORTING TO: Regional Service Manager

PAY STATUS: Non-Exempt

SUMMARY: Performs highly responsible technical work in providing professional service and training to ATL customers. Installs, troubleshoots and repairs the Mark I, II, II, IV systems and equipment down to the PCB level. May assist in the setting up, implementation and maintenance of a world-wide service organization. Duties include troubleshooting and repairing of customer-owned ATL equipment down to the PCB level; install and repair systems; maintain customer files for assigned area; serve as a liaison between field and technical support group; sell maintenance agreements; and assist sales force as required.

SCOPE OF RESPONSIBLITIES: The incumbent assigned to this position performs regular and highly technical independent work under the general supervision of the Regional Service Manager.

GENERAL DUTIES:

- Provide professional service and training to ATL customers.
- Provide customer engineering of approved changes required for specific installations.
- Troubleshoot and repair of customer-owned ATL equipment down to the PCB level.
- Install systems as required.
- Maintain customer service files for an assigned area.
- Provide assistance to sales force as required.
- Maintain company expense account and equipment issued to perform field service.
- Provide professional liaison between the field and technical support group on technical matters.
- Maintain an inventory of spare parts.
- Selling of maintenance agreements.
- Perform other specific or general tasks as assigned.

MINIMUM QUALIFICATIONS:	AA degree in electronics or equivalent and three years previous experience in troubleshooting, analog and digital circuits. One year of above experience. Must be at a TSR I level. Requires extensive car and/or air travel. Directly related experience may be substituted on a year-per-year basis for the required college training.

The statements contained herein reflect general details necessary to describe the principal functions of the job, the level of knowledge and skill typically required, and the scope of responsibility, but should not be considered an all-inclusive listing of work requirements. Individuals may perform other duties as assigned including work in other functional areas to cover absences or relief, to equalize peak work periods or to otherwise balance the work load.

5/16/80

EMPLOYEE _____

SUPERVISOR _____

COMPENSATION/
BENEFITS MANAGER _____

ATL JOB DESCRIPTION

POSITION TITLE: Technical Service Representative III

REPORTING TO: Regional Service Manager

PAY STATUS: Non-Exempt

SUMMARY: Performs highly responsible technical work in providing professional service and training to ATL customers. Installs, troubleshoots and repairs the Mark I, II, III, IV systems and equipment down to the component level. May assist in setting up, implementation and maintenance of a world-wide service organization. Duties include troubleshooting and repairing of customer-owned ATL equipment down to the component level; install and repair systems; maintain customer files for assigned area; serve as a liaison between the field and technical support group. Sell maintenance agreements; assist sales force as required.

SCOPE OF RESPONSIBLITIES: The incumbent assigned to this position performs regular and highly technical independent work under the general supervision of the Regional Service Manager.

GENERAL DUTIES:

- Provide professional service and training to ATL customers.
- Provide customer engineering of approved changes required for specific installations.
- Troubleshoot and repair of customer-owned ATL equipment down to the component level.
- Install systems as required.
- Maintain Customer Service files for an assigned area.
- Provide assistance to sales force.
- Maintain company expense account and equipment issued to perform field service.
- Provide professional liaison between the field and Technical Support Group on technical matters.
- Maintain an inventory of spare parts.
- Selling of maintenance agreements.
- Perform other specific or general tasks as assigned.

MINIMUM QUALIFICATIONS:	AA degree in electronics or equivalent and four years previous experience in troubleshooting, analog and digital circuits. Two years of above experience. Must be at a TSR II level. Requires extensive car and/or air travel. Directly related experience may be substituted on a year-per-year basis for the required college training.

The statements contained herein reflect general details necessary to describe the principal functions of the job, the level of knowledge and skill typically required, and the scope of responsibility, but should not be considered an all-inclusive listing of work requirements. Individuals may perform other duties as assigned including work in other functional areas to cover absences or relief, to equalize peak work periods or to otherwise balance the work load.

5/16/80

EMPLOYEE _____

SUPERVISOR _____

COMPENSATION/
BENEFITS MANAGER _____

ATL JOB DESCRIPTION

POSITION TITLE: Technical Service Representative IV

REPORTING TO: Regional Service Manager

PAY STATUS: Non-Exempt

SUMMARY: Performs highly responsible technical work in providing professional service and training to ATL customers. Installs, troubleshoots and repairs the Mark I, II, III, IV systems and equipment at all levels. May instruct and direct employees of a lower classification; may assist in the setting up, implementation and maintenance of a world-wide service organization. Duties include training of new technical service representatives. Assume Regional Service Manager's responsibilities when absent; troubleshooting and repair of customer-owned ATL equipment at all levels; install and repair systems; maintain customer files for assigned area; serve as a liaison between field and technical support group; sell maintenance agreements; assist sales force as required.

SCOPE OF RESPONSIBLITIES: The incumbent assigned to this position performs regular and highly technical independent work under the general supervision of the Regional Service Manager.

GENERAL DUTIES:

- May instruct and direct employees of a lower classification in the performance of specific work assignments and allocated work; determine priorities as necessary.
- Responsible for the training of all new technical service representatives.
- Assume Regional Service Manager's responsibilities when the latter is absent.
- Provide professional service and training to ATL customers.
- Provide customer engineering of approved changes required for specific installations.
- Troubleshoot and repair of customer-owned ATL equipment.
- Install systems as required.
- Maintain Customer Service files for an assigned area.

GENERAL DUTIES:
(Continued)

- Provide assistance to sales force.
- Maintain company expense acount and equipment issued to perform field service.
- Provide professional liaison between the field and Technical Support Group on technical matters.
- Maintain an inventory of spare parts.
- Selling of maintenance agreements.
- Perform other specific or general tasks as assigned.

MINIMUM QUALIFICATIONS:

AA degree in electronics or equivalent and five years previous experience in troubleshooting, analog and digital circuitry. Three years of above experience. Must be at a TSR III level. Requires extensive car and/or air travel.

Directly related experience may be substituted on a year-per-year basis for the required college training.

The statements contained herein reflect general details necessary to describe the principal functions of the job, the level of knowledge and skill typically required, and the scope of responsibility, but should not be considered an all-inclusive listing of work requirements. Individuals may perform other duties as assigned including work in other functional areas to cover absences or relief, to equalize peak work periods or to otherwise balance the work load.

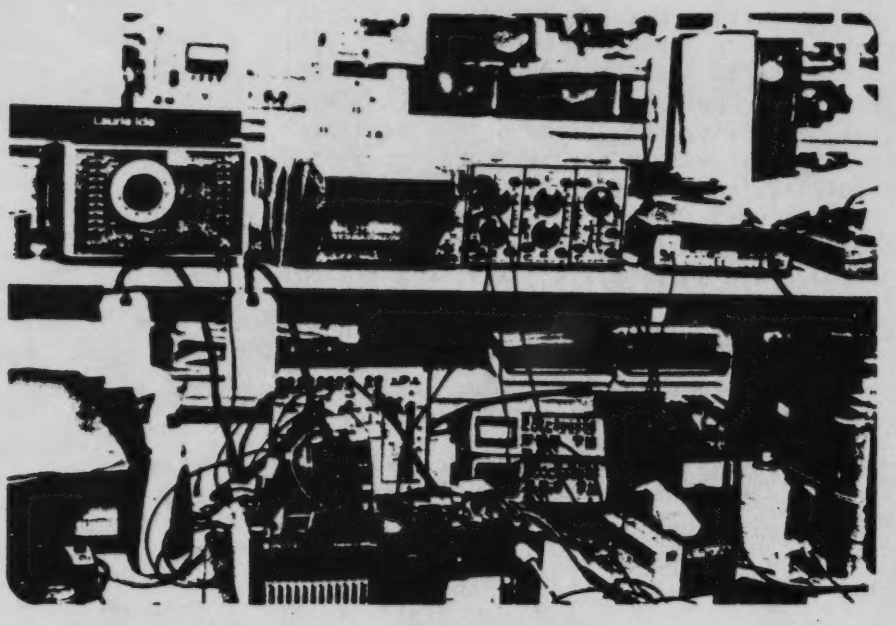
5/16/80

EMPLOYEE _____

SUPERVISOR _____

COMPENSATION/
BENEFITS MANAGER _____

PHYSIO-CONTROL CORPORATION



The business of Physio-Control is the design, manufacture and marketing of specialized electronic instrumentation for use in the cardio-vascular and dialysis fields of medicine.

JUNE 18, 1981

PHYSIO CONTROL

Career Path Opportunities

We recognize "promotion from within" as one of several cornerstones of good employment practice and it is therefore the philosophy of Physio-Control to promote from within whenever possible and/or appropriate when filling an opening. The job opening will generally be posted for one week to give all qualified full and part time Team Members an equal opportunity to apply.

Our goal is to continue to build the best Team possible. In doing so, some job openings must be filled so quickly that there is an immediacy to posting job openings. Keeping in mind that some openings are subject to these time limitations, sometimes an outside search must be conducted immediately in order to build our best possible Team!

Some of the key elements covered in our interviewing process include:

Experience

- Job Performance
- Job Proficiency (competence and skill levels)

Applicant-Job Match

- Evaluation of the criteria that show comparison of applicant's goals, needs, and attributes against key functional requirements of job.

Selections are made as soon as possible after the opening occurs.

DATE POSTED: June 15, 1981

TITLE: HUMAN RESOURCE MANAGER

DEPT/DIV. HUMAN RESOURCES/CORPORATE

DESCRIPTION: Responsible for the management of the training and employment functions within the Human Resources department. Develops and coordinates Team Member training and placement programs designed to provide a continuing flow of qualified Team Members to fill staffing requirements. Assesses the training needs of the corporation; develops and administers specialized training programs to meet those needs.

REQUIREMENTS: BA recommended in Business Administration with an emphasis in Human Resources; MBA desirable. Candidate requires diversified experience in Human Resource administration with 8 - 10 years practical experience Specialized knowledge in training program development is necessary.

INTERVIEWING MGR/SUPV.: John Price

PLEASE CONTACT EMPLOYMENT/HUMAN RESOURCES IF INTERESTED IN ANY POSITION.

DATE POSTED: June 17, 1981

TITLE: STOCK CLERK I

DEPT/DIV. MATERIEL DEPARTMENT/DIALYSIS

DESCRIPTION: Working in the shipping/staging vascular supplies group, at the direction of the assistant lead, prepares production lots for shipment to be sterilized and prepares records for these shipments. Repacks sterilized product and prepares customer shipments. Maintains records and related files. Maintains stock of finished goods and initiates stock transactions. In addition, assembles life kit products and maintains life kit inventories.

REQUIREMENTS: One year of related experience or equivalent training. Must have no lifting restrictions.

INTERVIEWING MGR/SUPV.: Mike Ryan

DATE POSTED: June 15, 1981

TITLE: ELECTRICAL RECEIVING INSPECTOR II (TEST TECH II)

DEPT/DIV. RECEIVING INSPECTION/QUALITY CONTROL CARDIOVASCULAR

DESCRIPTION: Performs electrical and visual inspection on electrical and electronic components and assemblies. Sets up and uses test equipment (oscilloscopes, curve tracers, I.C. testers, etc.). Maintains receiving inspection records and updates the drawings and test procedures as required. Performs inspection on mechanical parts using dial calipers and other precision tools. Performs first article inspection on new parts.

REQUIREMENTS: An AA degree in electronics, or equivalent experience required. Minimum of two years experience as a technician preferably in "receiving inspection". This is an experienced work level; work is not subject to close check; requires high degree of judgement, a good working knowledge of electronic component theory, transistors, I.C.'s, etc. Must be able to interpret complex blueprints. Assists the other areas of inspection as required.

INTERVIEWING MGR/SUPV.: Ross Henderson

DATE POSTED: June 4, 1981

TITLE: PRODUCTION TECHNICIAN II

DEPT/DIV. PRODUCTION - CARDIOVASCULAR

DESCRIPTION: Performs testing and troubleshooting of newly manufactured electronic assemblies. Works from blueprints, test procedures, schematics and other written materials. Utilizes test equipment such as oscilloscopes, signal generators and voltmeters to perform tests, and uses these instruments and others to create tests necessary to isolate malfunctions to the component level. Records data/malfunction information for reference.

REQUIREMENTS: Requires an AA degree in electronics or equivalent training or experience and a minimum of 1 year direct experience in the field as a technician. Background in life sciences helpful. Knowledge of analog and digital circuitry and good communication skills necessary.

INTERVIEWING MGR/SUPV.: Van Frazier

DATE POSTED: June 8, 1981

TITLE: OFFICE CLERK IV

DEPT/DIV. HUMAN RESOURCES/CORPORATE

DESCRIPTION: Provides general clerical support for the compensation and team relations functions. Inputs status changes on Team Members and maintains the on-line Human Resources data system. Prepares statistical recaps related to EEO and affirmative action matters. Types drafts of position descriptions and general compensation and team relations correspondence.

REQUIREMENTS: Prefer 3-4 years clerical experience, statistical and/or accounting experience and typing at 60 wpm. Must be detail-oriented and have an aptitude for working with numbers.

INTERVIEWING MGR/SUPV.: Joyce Cusack/Nance' Haydock

DATE POSTED: February 3, 1981

TITLE: QUALITY ENGINEER II

DEPT/DIV. QUALITY ASSURANCE/CARDIOVASCULAR

DESCRIPTION: Designs and implements systems and procedures related to product quality. Performs failure analysis and implements corrective action. Reviews engineering documentation and change proposals for configuration control and quality requirements. Analyzes production and field failure data. Provides management with summary reports of failure trends. Conducts product reliability and environmental tests.

REQUIREMENTS: Requires three years experience in failure analysis, systems evaluation, configuration management and other related quality programs. B.S.E.E. or equivalent professional quality engineering experience in the electronic or medical device industry required.

INTERVIEWING MGR/SUPV.: Darrell Whittaker

DATE POSTED: June 18, 1981

TITLE: ENGINEERING TECHNICIAN II

DEPT/DIV. ENGINEERING/CARDIOVASCULAR

DESCRIPTION: Works directly with Component/Standard and Reliability Engineer to perform component evaluation and product reliability testing. Plays an active role in the submission process to insure product compliance with federal agency standards. Responsibilities include: documentation of component specifications; reliability assurance calculations; component and product failure trend analysis; maintenance of vendor library.

REQUIREMENTS: Requires an AA in electronics or equivalent with a minimum 2 years related technical experience. Good verbal and written communication skills and organizational ability also necessary.

INTERVIEWING MGR/SUPV.: Al Hendrickson

DATE POSTED: June 1, 1981

TITLE: ASSEMBLY INSPECTOR I 2 dayshift/1 weekend

DEPT/DIV. QUALITY CONTROL - CARDIOVASCULAR

DESCRIPTION: Under the close supervision of a quality control supervisor and lead, the Inspector I performs basic inspections in the production post-assembly area. May check sub-assembly parts against assembly drawings to ensure use of specified parts and proper placement. May perform simple electrical tests. Completes routine paperwork such as checking for proper codes and dates, etc. May interface with Assemblers and Assembly Leads to communicate reasons for rejections, and answer routine quality-related questions.

REQUIREMENTS: Position requires sufficient related assembly/inspection experience to ensure a basic understanding of inspection techniques, familiarity with routine inspection paperwork and ability to read and interpret assembly drawings. Good verbal and written communication skills are required, and legible handwriting. Good judgment is required in rejection decisions and their communication to higher levels.

INTERVIEWING MGR/SUPV.: Tim Bergsma

DATE POSTED: June 16, 1981

TITLE: APPLICATIONS PROGRAMMER

DEPT/DIV. DATA PROCESSING/CORPORATE

DESCRIPTION: Develops business programs for computer processing of normal business operating problems. Work includes block diagramming, instruction sheet coding, assembling test data, debugging operations and documenting completed programs. Assignments are thoroughly explained with latitude for action in planning and executing details.

REQUIREMENTS: Requires an AA degree and two years experience in RPG2 (prefer IBM System 3) and Model 10.

INTERVIEWING MGR/SUPV.: Dick Pickering

DATE POSTED: May 21, 1981

TITLE: SENIOR PROJECT ENGINEER

DEPT/DIV. MONITOR ENGINEERING - CARDIOVASCULAR

DESCRIPTION: Responsible for the planning, design, development and implementation of major new products. This includes technical direction of both electrical and mechanical designers and the coordination of all support activities required from other departments.

REQUIREMENTS: BSEE is required, MSEE is preferred, or equivalent experience, plus a minimum of 5 years related experience, preferably in medical electronic instrumentation. Good written and verbal communication skills are essential.

INTERVIEWING MGR/SUPV.: Steve Firman

DATE POSTED: June 9, 1981

TITLE: SENIOR PROJECT ENGINEER

DEPT/DIV. DIALYSIS RESEARCH/DIALYSIS

DESCRIPTION: Responsible for the planning, designing, validating and budgeting of automatic assembly equipment for new disposable medical products. This includes: manufacturing feasibility analyses, process design support, production start-up, and special automatic assembly line equipment design.

REQUIREMENTS: BSME required or equivalent experience. Ten - fifteen years experience in the successful design of special high speed machinery. Formal training in plastic assembly concepts (e.g. ultrasonics) desirable.

INTERVIEWING MGR/SUPV.: Doug Hansmann

DATE POSTED: June 10, 1981

TITLE: PRODUCTION CONTROL SCHEDULER

DEPT/DIV. MATERIEL/CARDIOVASCULAR

DESCRIPTION: Responsible for setting and changing production schedules. Follows the flow of materials from order through receipt, production and inspection. Acts as liaison between production departments, product engineering, purchasing, and sales or contract departments. Issues periodic reports concerning status of current production and material efficiencies and insures the shipment of products as scheduled. May direct the work of production control personnel including expediters and clerks.

REQUIREMENTS: Two years business training or two years of directly related experience, plus minimum of 2 years previous experience related to the field of production/materiel control. Working knowledge of IPICS systems desirable. Familiarity with computer generated MRP required. Knowledge of configuration control techniques and ability to read drawings is helpful.

INTERVIEWING MGR/SUPV.: Dave Hadden

DATE POSTED: April 14, 1981

TITLE: PRODUCTION TECHNICIAN I

3 weekend shifts
1 dayshift

DEPT/DIV. PRODUCTION - CARDIOVASCULAR

DESCRIPTION: Performs testing and troubleshooting of newly manufactured electronic assemblies. Works from blueprints, test procedures, schematics and other written materials such as component data sheets. Utilizes test equipment such as oscilloscopes, signal generators and voltmeters to perform the prescribed tests and can use these instruments and others to create tests necessary to isolate malfunctions down to the component level. Accomplishes the repair of the assemblies to acceptable workmanship standards. Records data and malfunction information for future reference. Works under close supervision.

REQUIREMENTS: Requires an AA degree in electronics, or one year technical electronics training or equivalent experience.

INTERVIEWING MGR/SUPV.: John Hogan/Lucille Asis

DATE POSTED: June 15, 1981

TITLE: ELECTRONIC ASSEMBLER I 4 dayshift/1 weekend

DEPT/DIV. PRODUCTION/CARDIOVASCULAR

DESCRIPTION: Performs various production assembly operations on electronic components and subassemblies, such as, modules, panels, cables, or harnesses. Working under close supervision, uses visual aids, wiring lists, drawings, and verbal and written instructions to assemble, modify, rework or reassemble units.

REQUIREMENTS: Minimum of three months related assembly experience is required. PCB experience is preferred. Must be able to perform repetitive tasks. Good eyesight is essential.

INTERVIEWING MGR/SUPV.: Lucille Asis/Gary Sheneman/Brenda Graesser

DATE POSTED: June 4, 1981

TITLE: ELECTRONIC ASSEMBLY SPECIALIST I Weekend shift

DEPT/DIV. MANUFACTURING - CARDIOVASCULAR

DESCRIPTION: Performs rework and touch-up on printed circuit boards to conform to standards. Maintains associated assembly records. Initiates request for Engineering actions. Independently organizes work schedule.

REQUIREMENTS: Minimum of one year assembly experience on Physio-Control products. Prefer 2 years additional related assembly experience.

INTERVIEWING MGR/SUPV.: John Hogan

TITLE: SHIPPING CLERK

DEPT/DIV. FIELD SERVICE - CARDIOVASCULAR

DESCRIPTION: Prepares records of goods shipped and bills of lading, post weights, shipping charges, and maintains inventory status. Accepts telephone inquiries, mail orders, and processes goods for shipment.

REQUIREMENTS: This is an entry level position and requires "no lifting restrictions".

OPENINGS:	INTERVIEWING MANAGER:
Rowayton, CT (12/1/80)	T. Mirochna
Atlanta, GA (12/9/80)	R. Steward/B. Catner

TITLE: SALES REPRESENTATIVE

DEPT/DIV. MARKETING DEPARTMENT

DESCRIPTION: Acting as a representative of Physio-Control within an assigned territory. Maintains contacts with established customers and develops new prospects for the purpose of selling company products.

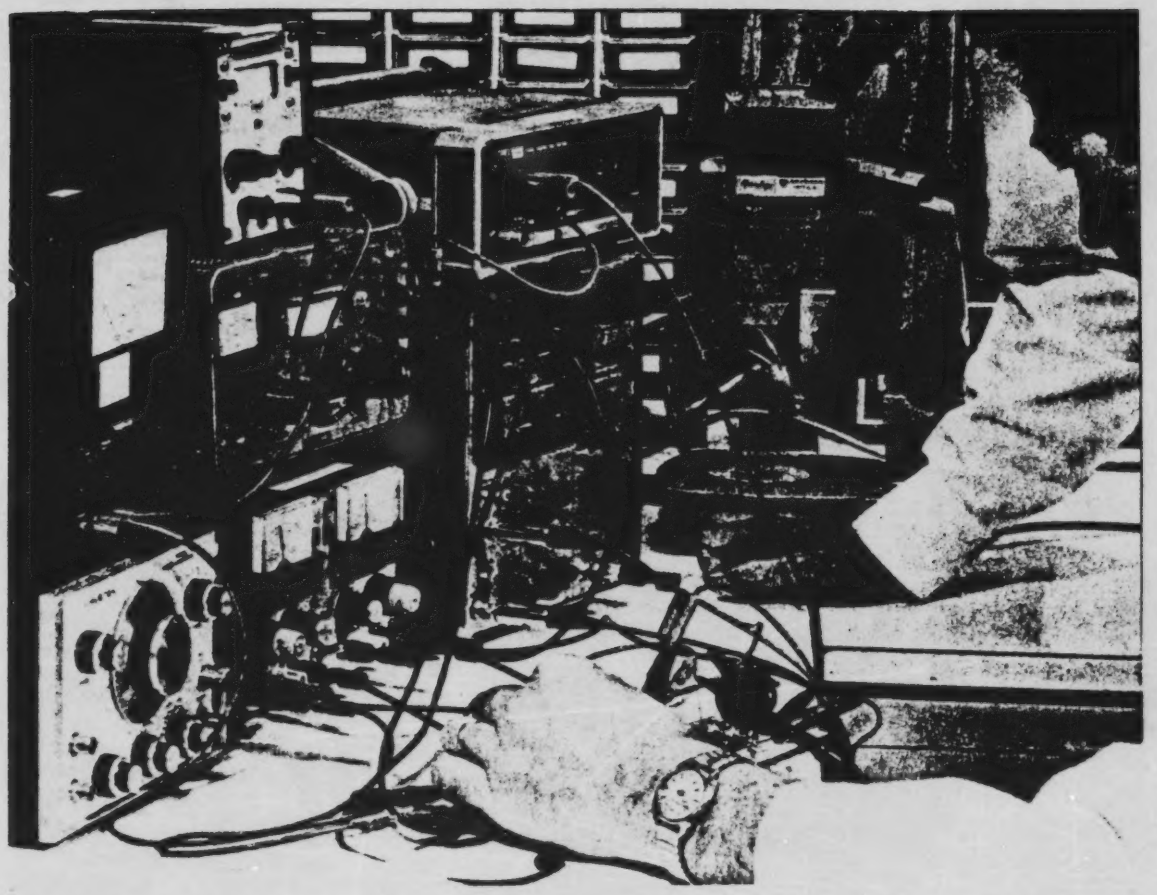
REQUIREMENTS: Three years successful outside sales experience, preferably in the medical and/or capital equipment market.

For all openings, the interviewing manager is the appropriate District Manager.

OPENINGS:

Quad Cities, Iowa (5/81)
Pittsburgh, PA (6/1/81) D. Boudreau

INTEGRATED CIRCUITS INCORPORATED



ICI's primary business is custom thick film hybrid circuits. ICI has specific experience in power conversion and regulator devices; complex active filters of the low-pass, high-pass, band-pass and band-reject types; linear circuits such as servo amplifiers, transducer signal conditioning electronics, tape read and disc read preamplifiers; high accuracy sample and hold circuits; D/A converters; timing devices; digital devices such as specially packaged memory systems, A/D converters and other logic systems.

INTEGRATED CIRCUITS INCORPORATED
13256 Northrup Way / Bellevue, Washington 98005/ Telephone (206) 747-8556

QUALITY ASSURANCE DEPARTMENT SKILL LEVELS

INTRODUCTION

The following job descriptions provide levels of knowledge, skill and experience for determining wages of all hourly employees within the Quality Assurance Department.

1.0 INSPECTORS

These positions are hourly classifications.

1.1 Trainee

The employee performs limited dimensional and visual inspection of hybrids, printed circuit boards and semi-conductor devices. Electrical testing of a "go-no-go" nature is performed where little latitude exists for desicions. The work is performed under close supervision and questionable quality is referred to the lead inspector. Microscopes, calipers, gauges and electronic measuring equipment are used in the performance of inspecting.

This is an entry level inspection job requiring no previous employment experience.

1.2 Level I

The employee performs dimensional, electrical and visual inspection of hybrids, printed circuit boards and semi-conductor devices using established industry and military standards. A basic understanding of all processes of thick film hybrid manufacturing is necessary to independently interpret drawings. The work requires using microscopes, calipers, gauges and electronic measuring equipment with normal supervisory assistance.

This level normally requires a minimum of one year of thick film hybrid assembly experience or 6 months of inspection experience.

1.3 Level II

The employee performs dimensional, electrical and visual inspection of hybrids, printed circuit boards and semi-conductor devices using established industry and military standards. A good understanding of all processes of thick film hybrid manufacturing is necessary to independently interpret drawings. The work requires skillful

use of microscopes, calipers, gauges and electronic measuring equipment with little supervisory assistance.

This level normally requires a minimum of two years accumulated thick film hybrid assembly and inspection experience.

1.4 Level III

The employee performs dimensional, visual and electrical inspection of hybrids, printed circuit boards and semiconductor devices. A thorough knowledge of the process procedures, inspection manual, military specifications and inspection tools associated with thick film hybrid manufacturing is necessary. Work includes receiving and in-process inspection with considerable responsibility in approving or rejecting. The employee works independently, seldom requiring supervisory or technical assistance.

This level normally requires four years accumulation of thick film hybrid assembly and inspection experience.

1.5 Lead

The employee performs dimensional, visual and electrical inspection on hybrids, components and materials. A thorough knowledge of the policy procedures, inspection manual, military specifications and inspection tools associated with hybrid manufacturing is required. The lead duties include assisting others on an instructional level in the use of inspection and manufacturing tools and works with manufacturing leads and supervisors to facilitate work flow. A high degree of professional judgement is required to deal with vendor discrepancies; often in direct contact with vendors.

This level normally requires a minimum of five years accumulation of thick film hybrid assembly and inspection experience.

2.0 ELECTRONICS TECHNICIANS

These positions are hourly classifications.

2.1 Trainee

The employee performs functional tests on hybrid circuits using standard test equipment and established test procedures. The employee is closely supervised and relies on higher classified employees to set up the test station

and to disposition discrepant units.

This is an entry level electronics technician job requiring electronics theory, trade school or military electronics school only.

2.2 Level I

The employee performs electrical and environmental tests on hybrid circuits using standard test equipment and established test procedures. The employee requires occasional supervisory and technical assistance to set up test stations, troubleshoot units and disposition units for rework.

This level normally requires a minimum of six months electronics theory, trade school or military electronics school, plus six months of electronic technician work experience.

2.3 Level II

The employee performs electrical and environmental tests on hybrid circuits using standard test equipment and established test procedures. The employee works independently to set up test stations and troubleshoot units that do not pass test. A basic understanding of all processes in hybrid manufacturing in necessary to disposition units that do not pass test. The work requires skillful use of test equipment with little supervisory or technical assistance.

This level normally requires a minimum of four years accumulation of electronics training, thick film hybrid and electronics technician experience.

2.4 Level III

The employee performs a combination of the following duties: In-process test, final test, environmental testing, troubleshooting and problem solving associated with hybrid testing. The work requires use of practical electronic theory, test procedures, schematics, assembly drawings and military standards associated with manufacturing hybrids. The employee works independently with little supervisory or technical assistance.

This level normally requires five years accumulation of electronics training, electronics technician work experience and thick film hybrid technology experience.

2.5 Lead

The employee performs a combination of the following duties: In-process test, final test, environmental test, troubleshooting and problem solving associated with hybrid testing. The work requires skillful use of practical electronic theory and a thorough knowledge of the policy procedures, test methods, military specifications and test equipment associated with hybrid manufacturing. As a lead the employee assists others on an instructional level in the use of test equipment and interpreting drawings and specifications.

This level normally requires a minimum of six years accumulation of electronics training, electronics technician work experience and thick film hybrid technology experience.

3.0 TEST ENGINEERS

The positions are monthly classifications.

3.1 Associate Test Engineer

The employee is able to perform circuit analysis utilizing electronic theory and electronic test equipment such as oscilloscopes, multimeters, counters and function generators. The employee performs one or any combination of the following duties: Test and troubleshoot ICI products; provides quality related technical assistance to Engineering and Manufacturing; reviews documentation for adequacy and accuracy; dispositions non-conforming material; recommends the acquisition of needed test equipment.

This position normally requires six years accumulation of electronics training, electronics technician work experience and thick film hybrid technology experience.

3.2 Test Engineer

The employee is able to perform in depth circuit analysis utilizing electronic theory and electronic test equipment such as oscilloscopes, multimeters, counters, function generators, wave analyzers, curve tracers and chart recorders. The employee performs one or any combination of the following duties: Test and troubleshoot ICI products; provides quality related technical assistance to Engineering and Manufacturing; reviews documentation for adequacy and accuracy; dispositions non-conforming material; prepares test insturctions; recommends the

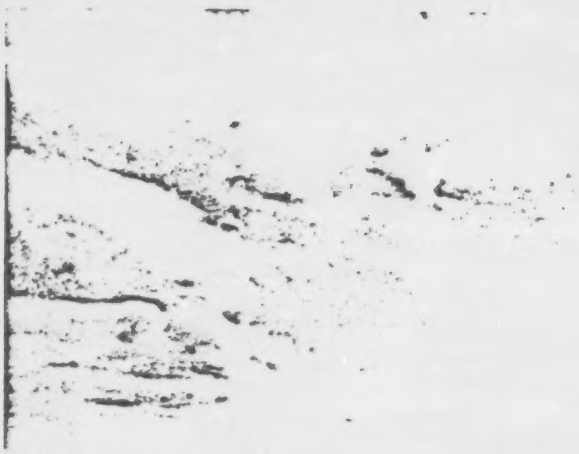
acquisition of needed test equipment.

This position normally requires a BSEE degree or equivilant training plus thick film process experience.

TESTER

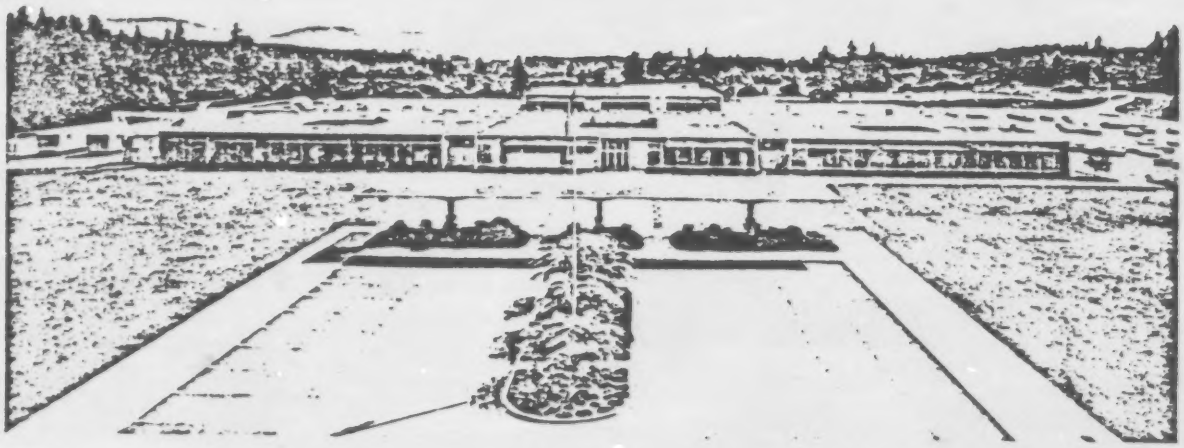
The employee performs functional and environmental tests on hybrid circuits using standard test equipment and established test prodecures. The employee is closely supervised and relies on higher classified employees to set up the test station and disposition discrepant units.

This is an entry level and electronics training or experience is not required although hybrid assembly experience is preferred.



Background and Fact Sheet

Sundstrand Data Control, Inc.
Overlake Industrial Park
Redmond, Washington 98052



Sundstrand Data Control, Inc. is located in Redmond, Washington's Overlake Industrial Park about 14 miles East of Seattle. The company is locally managed as a wholly owned subsidiary of Sundstrand Corporation headquartered in Rockford, Illinois. Sundstrand Data Control was founded in 1947 as United Control and was incorporated in 1948. It became a public company February 19, 1958 and moved from the Union Bay area of Seattle to the present site in April 1961. United Control was acquired by Sundstrand, a leading manufacturer and worldwide supplier of aircraft systems and industrial products on June 6, 1967 and changed its name to Sundstrand Data Control, Inc. in January 1971.

The company occupies a total of 306,000 square feet of floor space in five different locations. These include the four wholly owned buildings on the 33 acre headquarters site in Redmond, with leased buildings at its Paine Field Test Center, the Trans Com Division in Costa Mesa, California and Global Navigation facilities in Torrance, California and Prescott, Arizona. Operating facilities and equipment are unusually complete and as a part of Sundstrand Corporation, access to broadly based financial, technological, and service support is available to supplement Sundstrand Data Control's resources and capabilities.

The square footage for each functional division or operational center is listed below:

Main Plant and Corporate Offices	140,000
Fabrication Center	32,000
Instruments Building	40,000
Manufacturing Building	30,000
Flight Test Center	10,000
Trans Com Division	34,000
Global Navigation Division	20,000
TOTAL	306,000

A leading international supplier for more than 29 years Sundstrand Data Control products are in daily use around the world and beyond. Applications for these products include space craft, vehicle launchers, rockets, missiles, aircraft, aircraft terminals, surface ships, submarines, industrial plants, vertical and horizontal mines, offshore production platforms, the automotive industry, and research laboratories.

Major product areas are:

AVIONIC SYSTEMS. Primarily for use on aircraft, these highly sophisticated systems are designed specifically to increase operating efficiency and help ensure flight safety and comfort. Typical are:

Head up Displays
Energy Management Systems
Ground Proximity Warning Systems
Auto-Throttle Systems
Stall Warning Systems
Specialized Airborne Computers
In-Flight Monitors
Custom Designed Avionics
Temperature Controls

AIRBORNE RECORDERS AND FLIGHT DATA ANALYSIS SYSTEMS. Sundstrand's airborne recorders, which meet all government regulatory design and performance requirements, are crash survivable for recovery in event of an accident. The various ground based analysis equipments transcribe collected data into computer compatible format and "read" the information to help determine the cause of the incident. In this product group are:

Military Recorder Systems
Cockpit Voice Recorders
Flight Data Recorders
Maintenance Data Recorders
Aircraft Integrated Data Recorders
Serial Tape Converters
Incident Analysis Systems

AUDIO-VISUAL SYSTEMS. These products encompass a diverse line of passenger entertainment and announcement systems and include ground based terminal annunciators for public address. This line includes:

Super 8 mm Movie System
Audio Entertainment/Announce Systems
Hardwire Distribution Systems
Terminal Annunciators

INSTRUMENTATION PRODUCTS. The instrumentation product line features highly advanced designs used throughout the world in a wide variety of applications in industry, research laboratories, oceanography and aerospace. These include:

Servo Accelerometers
Angle of Attack Sensors
Signal Conditioning Electronics
Thermal Switches

NAVIGATIONAL SYSTEMS. Global Navigation VLF/OMEGA systems utilize very low frequency radio signals from two independent networks to provide highly accurate long-range navigation, worldwide. The system is used extensively for corporate jets and off-shore helicopters.

Customers and users include Government and Defense Agencies, NASA, most prime contractors, most airframe manufacturers, nearly all commercial airlines—worldwide, industrial plants, commercial business and research laboratories.

The Company's extensive technological capability is a balanced combination of such disciplines and functions as engineering, manufacturing, quality assurance, and follow-on field support. Equally important with this technological capability is the ability to apply these skills to the precise degree necessary to meet any given customer's requirements.

Sundstrand Data Control, Inc.
A unit of Sundstrand Corporation
Overlake Industrial Park, Redmond, WA 98052 (206) 885-3711 TWX 910-449-2860 Telex 32-0313

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Sundstrand

JOB DESCRIPTION

☐ OFFICE IC ☒ PRODUCTION & MAINT. (F

OCC. TITLE: Tester OCC. CODE: 246 SALARY CLASS OR PAY GRADE ____

DEPARTMENT: Quality Assurance DIVISION/SUBSIDIARY: Sundstrand Data Control

DATE: 7-1-80 DESCRIPTION STATUS: ☐ NEW ☒ REVISED SUPERSEDES: 3-8-78

JOB STATUS-OFFICE: ☐ NON-EXEMPT ☐ EXEMPT-TYPE: ____

JOB STATUS-PROD. & MAINT: ☒ DIRECT LABOR ☐ INDIRECT

General Statement

Utilizes standard instructions, procedures and drawings to perform testing and calibration of a variety of production components and assemblies. Is responsible for recognizing, interpreting and recording test results to determine functional quality. Must be familiar with Ohm's Law, color codes, and basic DC and AC theory.

Reports to: Supervisor, Quality Assurance

Duties and Responsibilities

1. Follows standard procedures to set dials, gauges and controls on test equipment to perform testing and calibration of production items.
2. Operates standard electronic equipment such as digital and differential voltmeters, power supply units, power amplifiers, ammeters, signal generators, oscilloscopes, bridges, megohmeters, insulation testers, and multimeters as required for testing electronic or electro-mechanical assemblies.
3. Analyzes and evaluates test results to determine functional quality of production units.
4. Makes routine continuity checks from test procedures, diagrams or wiring aids.
5. Operates test consoles and test systems for testing and data collection of production units.
6. Prepares test data, reports and written information as required.
7. Performs other duties as directed.

OCC. TITLE Tester OCC. CODE 240

Qualifications

Basic understanding of DC and AC circuitry and Ohm's Law
Ability to operate basic, general usage, electronic test equipment
Legible handwriting
Manual/mechanical dexterity
Competence in basic mathematics
Ability to use simple calculator

PREPARED BY: Ardis Kvare APPROVED BY: Ron Ericksen

Sundstrand Corporation

Wage & Salary Administration

FACTORY JOB DESCRIPTION

Job Title Electronic Technician I

Department Quality Assurance Division/Subsidiary Sundstrand Data Control, Inc.

Date: 2-14-74 Occ. Code: 8250 Labor Grade:

Job Description Status: New [X] Revised [ ] Supersedes:

Pay Status: [X] Non-Incentive [ ] Incentive Labor Status: [X] Direct [ ] Indirect

General Statement

Utilize detailed, standardized operation instructions and information to perform testing of a wide variety of production components and equipment. From shop specifications, diagrams, verbal and written instructions isolates and/or removes defective parts to meet approved quality standards. Diagnoses and troubleshoots malfunctions of the lessor complex type assemblies and/or units. Responsible for recognizing, interpreting and recording test results to determine functional quality.

Duties and Responsibilities

1. Determines, locates and utilizes correct procedures for testing units or assemblies.

2. Following standard procedures, performs proper instrument adjustments to calibrate and test production items.

3. Operates standard electronic and mechanical equipment including digital and differential voltmeters, power supply units, power amplifiers, ammeters, audio generators, etc. for testing electronic and electromechanical assemblies.

4. Locates malfunctions in equipment, assemblies and applies fundamental electronic, electrical and mechanical principles to troubleshoot units that are considered in the basic design category.

5. May disassemble and replace defective parts as necessary.

6. At this level, is able to interpret color codes on all components and understands and can apply basic mechanical operating principles on items such as cams, gears, levers, bearings, motors, linkages, relays, servos, syncros, and valves.

7. Makes routine continuity checks from schematics and wiring aids.

8. Provides and maintains technical data related to test and calibration methods, results and other requested data.

PREPARED BY: J. Barry APPROVED BY: Ralph Anderson

Sundstrand Corporation

Wage & Salary Administration

FACTORY JOB DESCRIPTION

Job Title Electronic Technician II

Department Quality Assurance Division/Subsidiary Sundstrand Data Control, Inc

Date: 2-14-74 Occ. Code: 8251 Labor Grade:

Job Description Status: New ☐ Revised ☒ Supersedes: 7-26-71

Pay Status: ☒ Non-Incentive ☐ Incentive Labor Status: ☒ Direct ☐ Indirect

General Statement Performs diversified product and component calibration and testing involving a wide scope of electronic, mechanical and environmental parameters. Utilizes standard procedures and/or engineering instructions to test and calibrate production and proto-type assemblies or units. Recognizes, interprets and records test results so that the proper corrective measures can be made and product reliability can be established and maintained. At this level, is familiar with the operation and capabilities of all commercial test equipment.

Duties and Responsibilities

1. Utilizing standard procedures as well as engineering instructions where technical details may be incomplete, tests and calibrates production and proto-type assemblies and units.

2. Operates electronic and mechanical equipment including digital and differential voltmeters, power supply units, vibration equipment, power amplifiers, frequency response recorders, megohmmeters, leakage testers, ammeters, audio generators, etc., to test assemblies.

3. Identifies and analyzes significant malfunctions and trends in equipment or components. Can determine cause of inoperability by analysis of schematics and with very little supervisory assistance.

4. Prepares technical data related to test and calibration methods and results. Can screen test documentation as to its accuracy and completeness, and initiates paper work to correct inaccuracies.

5. Assists in the setup and testing of units for evaluation in environmental conditions controlling temperature, relative humidity, barometric pressure, etc., as prescribed in test procedures. Operates related test equipment.

6. At this level, is capable of adapting regular test equipment to fit special tests. Can also work with a wide variety of test equipment and perform testing and calibration of more complex and precise assemblies or sub-assemblies; and is capable of explaining techniques or operations to lesser-skilled personnel.

PREPARED BY: J. Barry APPROVED BY: Ralph Anderson

Sundstrand Corporation

JOB DESCRIPTION

☒ OFFICE (O) ☐ PRODUCTION & MAINT. (F)

OCC. TITLE: Technical Writer OCC. CODE: 619 SALARY CLASS: OR PAY GRADE ____

DEPARTMENT: 048 - Tech Publications DIVISION/SUBSIDIARY: Sundstrand Data Control

DATE: 5/8/78 DESCRIPTION STATUS: ☐ NEW ☒ REVISED-SUPERSEDES: 12/16/76

JOB STATUS–OFFICE: ☐ NON-EXEMPT ☒ EXEMPT–TYPE: Professional

JOB STATUS–PROD. & MAINT: ☐ NON-INCENTIVE ☐ INCENTIVE ☐ DIRECT LABOR ☐ INDIRECT

General Statement

Responsible for the preparation and maintenance of various technical manuals, parts lists, service bulletins, and other related documents required for field product support. Coordinates with Manufacturing, Quality Assurance, Contracts, and other engineering personnel the activities required to collect and interpret input data. Schedules and prepares technical information required. Responsible for answering customers' technical questions and providing required publications.

Reports to: Supervisor, Technical Publications

Duties and Responsibilities

1. Responsible for developing detailed theory of operations required for technical manuals. Develops through analysis of engineering schematics and discussions with knowledgeable design engineers.

2. Responsible for developing detailed troubleshooting procedures, which are in accord with technical manual test procedures.

3. Responsible for the preparation of instruction manuals for non-repairable instruments. The instructions are designed to allow the users to maximize the utility of the instrument.

4. Prepares, maintains and updates commercial and military manuals, parts lists, test reports, service bulletins, and miscellaneous data lists. Accomplishes this function by assembling and evaluating information from engineering and customer specifications, vendor catalogs and other miscellaneous documents.

Duties and Responsibilities (Continued)

5. Responsible for coordinating activities with Manufacturing, Quality Assurance, Contracts, and other Engineering departments in order to better prepare and interpret technical information.

6. Responds to customer needs for technical information and materials.

7. Responsible for scheduling and planning the preparation of technical information in order to forecast related costs and manpower requirements.

8. Performs related tasks as necessary. These may include assisting other personnel responsible for the reproduction of written materials.

PREPARED BY: J. Zoller APPROVED BY: D. Veal

JOHN FLUKE MANUFACTURING COMPANY, INC.

John Fluke Manufacturing Company, Inc. had its beginning in 1948 in the home of John M. Fluke. The first product was one John designed himself--an instrument that measured electrical volts, amps and watts. Although unsophisticated by today's standards, the instrument embodied good, innovative engineering, satisfied an important need and was sold for a long time. Fluke now designs, manufactures and markets over one hundred kinds of electronic test and measurement instruments.

Except for logic circuit testers, which are designed in Mountain View, California, all Fluke instruments are designed at Mountlake Terrace, Washington.

Fluke products are sold in more than fifty countries worldwide.

CHAPTER V

SURVEY OF THE ELECTRONIC TECHNICAL NEEDS OF INDUSTRY

Working with the electronic advisory committee, a questionnaire survey was devised, and sent to over sixty electronic industries to obtain information about the technological needs of the companies relating to electronic technicians. Approximately one-third were returned.

The first four items requested general information about the company. In order to identify the nature of the sample, information was needed concerning (1) the company's industrial classification according to types of products, (2) its basic organization, (3) the gross dollar value of its industrial product(s) and (4) the number of people employed. The next eleven items dealt with the number and type of electronic technicians in their company. The next seven questions dealt with the educational background of their technicians and future needs for electronic technicians. The later part of the questionnaire was designed to identify specific curricular needs in the training of electronic technicians. The respondents were asked to check those courses opposite the type of technician which they felt were essential or advisable preparation for the electronic technicians employed in their company. Different symbols

were used to designate essential or advisable courses. In addition, the respondents were asked to write in additions if the listing did not include the type of electronic technician employed in their company or courses felt to be desirable. The results provided by the respondents are summarily displayed by the charts included in this chapter.

FIGURE 1. INDUSTRIAL CLASSIFICATIONS OF RESPONDENTS

Industrial Classification	Number of Respondents	Percentage of Respondents
1. Aerospace	4	20
2. Avionics	1	5
3. Communications	4	20
4. Consumer Audio	1	5
5. Instrument	4	20
6. Medical electronics	4	20
7. Computer	2	10

FIGURE 2. BASIC COMPANY ORGANIZATION OF RESPONDENTS

Basic Organization	Number of Respondents	Percentage of Respondents
1. Local	7	35
2. Regional (several states)	1	5
3. National (all states	2	10
4. International	10	50

The study endeavored to provide representation for the broad financial spectrum of industry and the number of people employed. Figures 3 and 4 show that both the larger and smaller companies are well represented.

FIGURE 3. COMPANIES BY GROSS INDUSTRIAL PRODUCT

Dollar Value			Number of Respondents	Percentage of Respondents
1.	$ 0.0 -	200,000	1	5
2.	200,000 -	500,000	1	5
3.	500,000 -	1,000,000	2	10
4.	1,000,000 -	2,000,000	2	10
5.	2,000,000 -	5,000,000	6	30
6.	5,000,000 -	10,000,000	2	10
7.	10,000,000 -	20,000,000	2	10
8.	20,000,000 -	50,000,000	4	20

FIGURE 4. COMPANIES IN EMPLOYMENT CATEGORIES

Number of Employees			Number of Companies	Percentage of Companies
1.	1 -	24	3	15
2.	25 -	49	1	5
3.	50 -	99	4	20
4.	100 -	249	3	15
5.	250 -	499	4	20
6.	500 -	999	2	10
7.	1,000 -	4,999	3	14

FIGURE 5. ELECTRONIC TECHNICIANS EMPLOYED BY CLASSIFICATION

	Number	Percent
Total	620	100
Manufacturing, Production or Factory	186	30
Automatic Test Equipment Operators	72	12
Quality Assurance Technicians	146	24
Engineering, Design or R & D	100	16
Customer Service or Field Service	61	10
Communications Electronic Technicians	33	5
Technical Writers	11	2
Calibration	11	2

As indicated by Figure 5, nearly one out of three of the total employed were classified as either manufacturing, production, or factory electronic technicians. Nearly one out of four was a quality assurance technician, with one out of six being either an engineering, design or R & D technician.

Since nearly every company classifies their technicians differently, it is difficult to get absolute numbers. However, the figures in Figure 5 do give a general indication. Automatic test operators are a relative new position, as industry is switching over to computer controlled automatic testing devices. Automatic test operators should increase dramatically the next few years.

FIGURE 6. EDUCATIONAL BACKGROUND OF ELECTRONIC TECHNICIANS

Educational Background	Number	Percent
1. Less than high school graduation	5	.81
2. High school graduation	25	4.03
3. Military experience	95	15.32
4. One year of college	85	13.71
5. Two years of college or Associates degree	395	63.70
6. Four years of college or Bachelors degree	14	2.26
7. Education beyond BS degree	1	.16

As indicated in Figure 6, the educational background of electronic technicians came out as expected. It seems for the most part, that either an Associate degree in electronics or military experience is the passport for a career as an electronics technician.

FIGURE 7. RANK OF EDUCATIONAL PREFERENCE

Program	Rank 1		Rank 2		Rank 3		Rank 4	
	#	%	#	%	#	%	#	%
1. Technical H. S.	0	0	0	0	0	0	6	4
2. Two yr private tech	0	0	1	5	3	16	3	16
3. Two yr public tech	2	11	3	16	3	16	4	21
4. Two yr comm college	8	42	7	36	2	11	1	5
5. Four yr tech programs	0	0	4	21	1	5	1	5
6. Other companies	8	42	5	26	2	11	1	5
7. Own in-service	1	5	0	0	1	5	1	11
8. Other (military)	1	5	0	0	6	32	1	5

It should be noted that in answering the above, the respondents selected the top four programs out of eight, being obliged to omit the remaining four choices. These percentages reflect, in part, the experience that the companies have had with these types of programs. The data

suggests that more companies have had experience with technicians from community colleges and from other companies, than with technicians from any other type of training program. Since there are very few technical high schools in the area and few companies have their own in-service programs, relatively few selected these programs as one of the top four.

FIGURE 8. FREQUENCY OF TECHNICAL TRAINING PREFERENCES

Preference	Number of Respondents	Percentage of Respondents
1. General Technical Training	13	65
2. Specific Technical	7	35

As indicated by Figure 8, approximately two-thirds of the respondents indicated that they favored general technical training to specific technical training.

FIGURE 9. NUMBER OF TECHNICIANS ACQUIRED IN LAST TWO YEARS FROM GIVEN SOURCES

Sources	Number
1. Two year private tech schools	10
2. Two year public tech schools	5
3. Community colleges	230
4. High schools	3
5. Four year colleges and universities	2
6. Experienced technicians from other companies	90
7. Upgrade from your production areas	27
8. Other (military)	22

The respondents indicated that approximately sixty percent of the technicians acquired within the past two years came from community colleges, with approximately twenty-three percent from experienced technicians from other companies. Some of the companies, especially in the San Jose area, admit that they "steal" most of their technicians from other companies. Many companies have a program to update their production workers to technicians, so it is expected that this source will produce more electronic technicians in the future.

FIGURE 10. AVAILABLE IN-PLANT TRAINING PROGRAMS FOR TECHNICIANS

Report	Number of Respondents	Percentage of Respondents
Had Program	4	20
Had no Program	16	80

Only twenty percent of the respondents indicated that they had an in-plant training program for their technicians. If we consider "over the shoulder" on-the-job training as in-plant training, this number would jump to one-hundred percent. Many of the companies visited had individualized training facilities. It is suspected that the respondents considered the question to consider only formal in-plant training.

FIGURE 11. IN-SERVICE TRAINING PROGRAMS USING FACILITIES OF NEIGHBORING EDUCATIONAL INSTITUTIONS

Report	Number of Respondents	Percentage of Respondents
Had Program	5	25
Had no Program	15	75

Three-fourths of the respondents indicated that they did not have an in-service training program with neighboring educational institutions. In the San Jose area there is an intensive cooperative training program between

industry and the educational community. This is an area of concern that should be addressed in the Puget Sound area.

FIGURE 12. ESTIMATED NUMBER OF ELECTRONIC TECHNICIANS NEEDED IN THE NEXT FIVE YEARS

Area of Technology	Number of Technicians	Percent of Technicians
1. Manufacturing, Production or Factory	295	40
2. Test Equipment Operator	93	12
3. Quality Assurance	151	20
4. Engineering, Design or R & D	99	13
5. Customer or Field Service	50	7
6. Communications	12	2
7. Technical Writer	45	6

Forty percent of the electronic technicians needed in the next five years will be in the manufacturing, production or factory areas. Keep in mind these are probably the same type of areas with different companies using different names for their technicians. Quality assurance technicians were next with twenty percent with test equipment operators and engineering, design or R & D having about twelve percent each.

CHAPTER VI

ELECTRONICS TECHNICAL TRAINING ANALYSIS

The latter part of the survey was designed to identify specific curricular needs for the electronics technician.

The courses were listed in four areas of study: mathematics, physics, general and electronics. The respondents were asked to check those courses opposite the type of electronics technicians employed in their company, which they felt were essential or advisable. Different symbols were used to designate essential or advisable courses. In addition, the respondents were asked to write in additions if the listing did not include occupations represented by electronics technicians employed in their company or courses felt desirable.

The results provided by the respondents for each type of electronics technician are summarily displayed by the graph charts included in this chapter.

The length of the XXXXXX indicates the percentage of the responding companies which felt that a given course was essential. The length of the OOOOOOOO represents the percentage of responding companies which felt that the course was advisable. Interpreting these graphs, the total length of the XXXXOOOO represents the percentage of responding companies which felt that the course should be taken, and the length of the XXXXXXXX alone represents the percentage of responding companies which felt that the course must be taken.

FIGURE 13. MANUFACTURING, PRODUCTION OR FACTORY ELECTRONICS TECHNICIANS

FIG. 13. cont. MANUFACTURING, PRODUCTION OR FACTORY ELECTRONICS TECHNICIANS

COURSES	0 10 20 30 40 50 60 70 80 90 100
62. Superposition	XXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
63. Thevenin's Theorem	XXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
64. Norton's Theorem	XXXXXXXXXXXXXXXXXXOOOOOO
65. Millman's Theorem	XXXXXXXXXXXXXXXXXXOOOOOO
66. Kirchhoff's Current Law	XXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
67. Kirchhoff's Voltage Law	XXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
70. Reading Schematics	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
71. Using Hand Tools	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
72. Soldering Techniques	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
73. Use of Meters	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
74. Nontriggered Scopes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
75. Triggered Scopes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
76. Use of Bridges	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
79. AC Voltage & Current	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
80. Inductance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
81. Ind. Reactance & Cir.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
82. Capacitance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
83. RC & L/R Time Con.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
84. Cap Reactance & Cir.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
85. Impedance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
86. Power Factor	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
87. J Operator	XXXXXXXXXXXXXXXXXXXXXXOOOOOO
88. Resonance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
89. Filters	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
95. Approximations	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOO
96. Semiconductory Theory	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
97. Diodes & Circuits	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
98. Bipolar Transistors	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
99. Transistor Biasing	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
100. AC Equivalent Cir.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
101. Small-signal Amp.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
102. Class A Pwr. Amp.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
103. Class B Push-Pull	XXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOO
104. Class C Pwr. Amp.	XXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOO
105. Field Effect Transis.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
106. FET Cir. Analysis	XXXXXXXXXXXXXXXXXXXXXXXXXX
107. Decibels	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
108. Hybrid Parameters	XXXXXXXXXXXXOOOOOOO
114. Frequency Effects	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
115. Integrated Circuits	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOO
116. Neg. Feedback, Op Amps.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
117. Pos. Feedback, Osc.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
118. Voltage Regulation	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
119. Op-Amp Applications	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOO
120. Active Filters	XXXXXXXXXXXXXXXXOOOOOOOOOO

Fig. 13. cont. MANUFACTURING, PRODUCTION OR FACTORY ELECTRONICS TECHNICIANS

COURSES	0 10 20 30 40 50 60 70 80 90 100
121. Frequency Domain	XXXXXXXXXXXXXOOOOOO
122. Modulation	XXXXXXXXXXXXXXXOOOOOO
123. Vacuum Tubes	XXXXXXXXX
129. De Morgan's Theorem	XXXXXXXXXXXXXOOOO
130. Karnaugh Maps	XXXXXXXXXXXXXOOOO
131. TTL Digital IC's	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
132. CMOS Digital IC's	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
133. Boolean Algebra	XXXXXXXXXXXXXXXXXXXXOOOOOOOO
134. Microprocessor Prog.	XXXXXXXXXXXXXXXXXXOOOOOOOO
135. Use of Assemblers	XXXXXXXXXXXXXXOOOOO
136. LSI-II	XXXXXXXXXXXXOOOOOOO
137. Semiconductor Mem.	XXXXXXXXXXXXXXXXXXXXXOOOOOO
138. Development Systems	XXXXXXXXXXXXXXOOOOOOOO
139. Microprocess Interf.	XXXXXXXXXXXXXXXXXXXXOOOOOO
140. Logic Analyzers	XXXXXXXXXXXXXXXXXXXXXOOOOOOOO
141. Floppy Disk Drives	XXXXXXOOOOOO
142. 16 Bit Microprocessors	XXXXXXOOOOOOOO
143. Hard Disc Drivers	XXXXXOOOOOOO
144. Display Systems	XXXXXXXXXXOOOO
145. U.V. Eraseable Proms	XXXXXXXXOOOOOOOOOOO
151. Phase Lock Loops	XXXXXXXXXXXXXOOOOOO
152. Power Control	XXXXXXXXXXXXXOOOOOO
153. Data Communications	XXXXXXXOOOOOOOOOOOOO
154. RS-232 Standards	XXXXXXXXXXXXXXXXOOOOO
155. IEEE-488 Bus Standards	XXXXXXXXXXXXOOOOO
156. Intel Multibus or PBS	XXXXXXXOO
157. Modems	OOOOOOOOO
158. Printers	OOOOOOO
159. Fortran or Basic	XXXXXXXXXOOOOOOOOO

FIGURE 14. AUTOMATIC TEST EQUIPMENT OPERATOR

FIG. 14.cont. AUTOMATIC TEST EQUIPMENT OPERATOR

COURSES	0 10 20 30 40 50 60 70 80 90 100
70. Reading Schematics	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
71. Using Hand Tools	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
72. Soldering Techniques	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
73. Use of Meters	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
74. Nontriggered Scopes	XXXXXXXXXXXXXXXXXXXXXXXOOOOOOO
75. Triggered Scopes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
76. Use of Bridges	XXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOO
79. AC Voltage & Current	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
80. Inductance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
81. Ind React. & Circuits	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
82. Capacitance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
83. Cap React. & Circuits	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
84. RC & L/R time Constants	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
85. Impedance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
86. Power Factor	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
87. J Operator	XXXXXXXXXXXXXXXXXXXXXX
88. Resonance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
89. Filters	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
95. Approximations	XXXXXXXXXXXXXXXX
96. Semiconductor Theory	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
97. Diodes & Circuits	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
98. Bipolar Transistors	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
99. Transistor Biasing	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
100. AC Equivalent Circuits	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
101. Small Signal Amp.	XXXXXXXXXXXXXXXXOOOOOO
102. Class A Power Amp.	XXXXXXXXXXXXXXXXOOOOOO
103. Class B Push-Pull	XXXXXXXXXXXXXXXXOOOOOO
104. Class C Power Amp.	XXXXXXXXXXXXXXXXOOOOOO
105. Field Effect Transistors	XXXXXXXXXXXXXXXXOOOOOO
106. FET Circuit Analysis	XXXXXXXXXXXXXXXXOOOOOO
107. Decibels	XXXXXXXXXXXXXXXXOOOOOO
108. Hybrid Parameters	XXXXXXOOOOOO
114. Frequency Effects	XXXXXXXXXXXXXXXX
115. Integrated Circuits	XXXXXXXXXXXXXXXXXXXXX
116. Neg Feedback, OP AMPS	XXXXXXXXXXXXXXXXXXXXX
117. Pos Feedback, Osc.	XXXXXXXXXXXXXXXXXXXXX
118. Voltage Regulation	XXXXXXXXXXXXXXXXXXXXX
119. Op-Amp Applications	XXXXXXXXXXXXXXXXXXXXX
120. Active Filters	XXXXXXXXXXXXXXXXXXXXX
121. Frequency Domain	XXXXXXXXXXOOOOOO
122. Modulation	XXXXXXXXXXOOOOOO
123. Vacuum Tubes	XXXXXXXXXXOOOOOO

FIG. 14. cont. AUTOMATIC TEST EQUIPMENT OPERATOR

COURSES	0 10 20 30 40 50 60 70 80 90 100
129. De Morgan's Theorem	XXXXXXXXXXXXXXXXXX
130. Karnaugh Maps	XXXXXXXXXXXXXXXXXX
131. TTL Digital IC's	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOO
132. CMOS Digital IC's	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOO
133. Boolean Algebra	XXXXXXXXXXXXXXXXXXXXXXXXXXX
134. Microprocessor Program	XXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
135. Use of Assemblers	XXXXXXXXXXXXXXXXXXXXXXXX
136. LSI-II	XXXXXXXXXXXXXXXXXX
137. Semiconductor Memories	XXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
138. Development Systems	XXXXXXXXXXXXXXXXXXOOOOOO
139. Micropro. Interfacing	XXXXXXXXXXXXXXXXXXOOOOOO
140. Logic Analyzers	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
141. Floppy Disk Drives	XXXXXXXXXXXXOOOOOOOOOOOO
142. 16 Bit Microprocessors	XXXXXXXXXXXXOOOOOOOOOOOO
143. Hard Disk Drivers	XXXXXXXXXXXXXXXXXXOOOOOO
144. Display Systems	XXXXXXXXXXXXXXXXXXOOOOOO
145. U. V. Eraseable Proms	XXXXXXXXXXXXXXXXXXOOOOOO
151. Phase Locked Loops	XXXXXXXXXXXXXXXXXXOOOOOO
152. Power Control	XXXXXXXXXXXXXXXXXXOOOOOO
153. Data Communications	XXXXXXXOOOOOO
154. RS-232 Standards	XXXXXXXXXXXXXOOOOOO
155. IEEE-488 Bus Standards	XXXXXXXXXXXXXXXXXX
156. Intel Multibus or PBS	XXXXXXXXXXXXX
157. Modems	OOOOOOOOOOOOO
158. Printers	XXXXXXXXOOOOO
159. Fortran or Basic	XXXXXXXXXXXXXOOOOOO

FIGURE 15. QUALITY ASSURANCE ELECTRONICS TECHNICIAN

Fig. 15. cont. QUALITY ASSURANCE ELECTRONICS TECHNICIAN

COURSES	0 10 20 30 40 50 60 70 80 90 100
62. Superposition	XXXXXXXXXXXXXXXXXXXXXXXOOO
63. Thevenin's Theorem	XXXXXXXXXXXXXXXXXXXXXXXXOOOO
64. Norton's Theorem	XXXXXXXXXXXXXXXXXXXXXXXOOO
65. Millman's Theorem	XXXXXXXXXXXXXXXXXXXXXX
66. Kirchhoff's Current Law	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
67. Kirchhoff's Voltage Law	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
70. Reading Schematics	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
71. Using Hand Tools	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
72. Soldering Techniques	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
73. Use of Meters	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
74. Nontriggered Scopes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
75. Triggered Scopes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
76. Use of Bridges	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOO
79. AC Voltage & Current	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
80. Inductance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
81. Ind Reactance & Cir.	XXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOOO
82. Capacitance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
83. Cap Reactance & Cir.	XXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOO
84. RC & R/L time Constant	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
85. Impedance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
86. Power Factor	XXXXXXXXXXXXXXXXXXXOOOOOOOOOOO
87. J Operator	XXXXXXXXXXXXXXXXXXXOOOOOOOOOO
88. Resonance	XXXXXXXXXXXXXXXXXXXOOOOOOOOOOOOOOOOOOOOO
89. Filters	XXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOOOOOOOOOO
95. Approximations	XXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
96. Semiconductor Theory	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
97. Diodes & Circuits	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
98. Bipolar Transistors	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
99. Transistor Biasing Cir.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
100. AC Equivalent Cir.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
101. Small Signal Amp.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
102. Class A Pwr. Amp.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
103. Class B Push-Pull	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
104. Class C Pwr. Amp.	XXXXXXXXXXXXXXXXOOOOOOOOOOOO
105. Field-Effect Trans.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOO
106. FET Cir. Analysis	XXXXXXXXXXXXXXXXXXXX
107. Decibels	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
108. Hybrid Parameters	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
114. Frequency Effects	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
115. Integrated Circuits	XXXXXXXXXXXXXXXXXXXX
116. Neg Feedback, OP AMPS	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
117. Pos Feedback, Osc.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
118. Voltage Regulation	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO

Fig. 15. cont. QUALITY ASSURANCE ELECTRONICS TECHNICIAN

COURSES	0 10 20 30 40 50 60 70 80 90 100
119. Op-Amp Applications	XXXXXXXXXXXXXXXXXXXOOOO
120. Active Filters	XXXXXXXXXXXXXOOOOOOOOOOO
121. Frequency Domain	XXXXXXXXXXXXXXOOOO
122. Modulation	XXXXXXXXXXXXXOOOOOO
123. Vacuum Tubes	XXXXXXXXXXXXX
129. De Morgan's Theorem	XXXXXXOOOOOOO
130. Karnaugh Maps	XXXXXXOOOOOOO
131. TTL Digital IC's	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
132. CMOS Digital IC's	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
133. Boolean Algebra	XXXXXXXXXXXXXXXXXXXXXOOOOOOO
134. Microprocessor Program	XXXXXXXXXXXXXXXXXOOOOOOO
135. Use of Assemblers	XXXXXXXXXXOOOOOOOOOO
136. LSI-II	XXXX
137. Semiconductor Memories	XXXXXXXXXXXXXXXXXOOOOOOOOOOO
138. Development Systems	XXXXXXXXXXXXXOOOOOOOOOO
139. Microprocess Interfac	XXXXXXXXXXXXXOOOOOOOOOOO
140. Logic Analyzers	XXXXXXXXXXXXXXXXXOOOOOOOOO
141. Floppy Disk Drives	XXXXXXXOOOOOOO
142. 16 Bit Microprocessor	XXXXXXXOOOOOOOOOOO
143. Hard Disk Drivers	XXXXOOOOOOOOOOO
144. Display Systems	XXXXXXXXOOOOOOOOOO
145. U. V. Eraseable Prom	XXXXXXXXXXXXOOOOOOOOOO
151. Phase Locked Loops	XXXXXXXOOOOOOOOOOO
152. Power Control	XXXXXXXXXXXXXXOOOOO
153. Data Communications	XXXXXXXOOOOOOOOOO
154. RS-232 Standards	XXXXXXXOOOOOOOOOO
155. IEEE-488 Bus Standard	XXXXXXXOOOOOOOOOO
156. Intel Multibus or PBS	XXXXXXXOOOOOOOOOO
157. Modems	OOOOOOOOOO
158. Printers	OOOOOOOOOO
159. Fortran or Basic	XXXXXXXXXXXXXXOOOOOOOOOO

FIGURE 16. ENGR., DESIGN OR R & D ELECTRONICS TECHNICIAN

Fig. 16. cont. ENGR., DESIGN OR R & D ELECTRONICS TECHNICIAN

COURSES	0 10 20 30 40 50 60 70 80 90 100
62. Superposition	XXXX

Fig. 16. cont. ENGR., DESIGN OR R & D ELECTRONICS TECHNICIAN

COURSES	0 10 20 30 40 50 60 70 80 90 100
119. Op-Amp Applications	XXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOO
120. Active Filters	XXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOOO
121. Frequency Domain	XXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOOO
122. Modulation	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOO
123. Vacuum Tubes	XXXXXXXXXXXXXXXXXOOOOO
129. De Morgan's Theorem	XXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
130. Karnaugh Maps	XXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
131. TTL Digital IC's	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
132. CMOS Digital IC's	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
133. Boolean Algebra	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
134. Microprocessor Program	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOO
135. Use of Assemblers	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
136. LSI-II	XXXXXXXXXXXXOOOOO
137. Semiconductor Memories	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOO
138. Development Systems	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOO
139. Microprocess Interfac	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOO
140. Logic Analyzers	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
141. Floppy Disk Drives	XXXXXXXXXXXXXXXXX
142. 16 Bit Microprocessor	XXXXXXXXXXXXXXXXXOOOOOOOOO
143. Hard Disk Drivers	XXXXXXXXXXXXXXXXXOOOO
144. Display Systems	XXXXXXXXXXXXXXXXXXXXXOOOO
145. U.V. Eraseable Proms	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
151. Phase Lock Loops	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOO
152. Power Control	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOO
153. Data Communications	XXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOO
154. RS-232 Standards	XXXXXXXXXXXXXXXXXXOOOOOOOOOOOOOO
155. IEEE-488 Bus Standard	XXXXXXXXXXXXXXXXXXOOOOOOOOOOOOOO
156. Intel Multibus or PBS	XXXXXXXXXXXXXXXXXXOOOO
157. Modems	XXXXXXXXXXXXXXXXXX
158. Printers	XXXXXXXXXXXXXXXXXXOOOO
159. Fortran or Basic	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO

FIGURE 17. CUSTOMER SERVICE & FIELD SERVICE TECHNICIAN

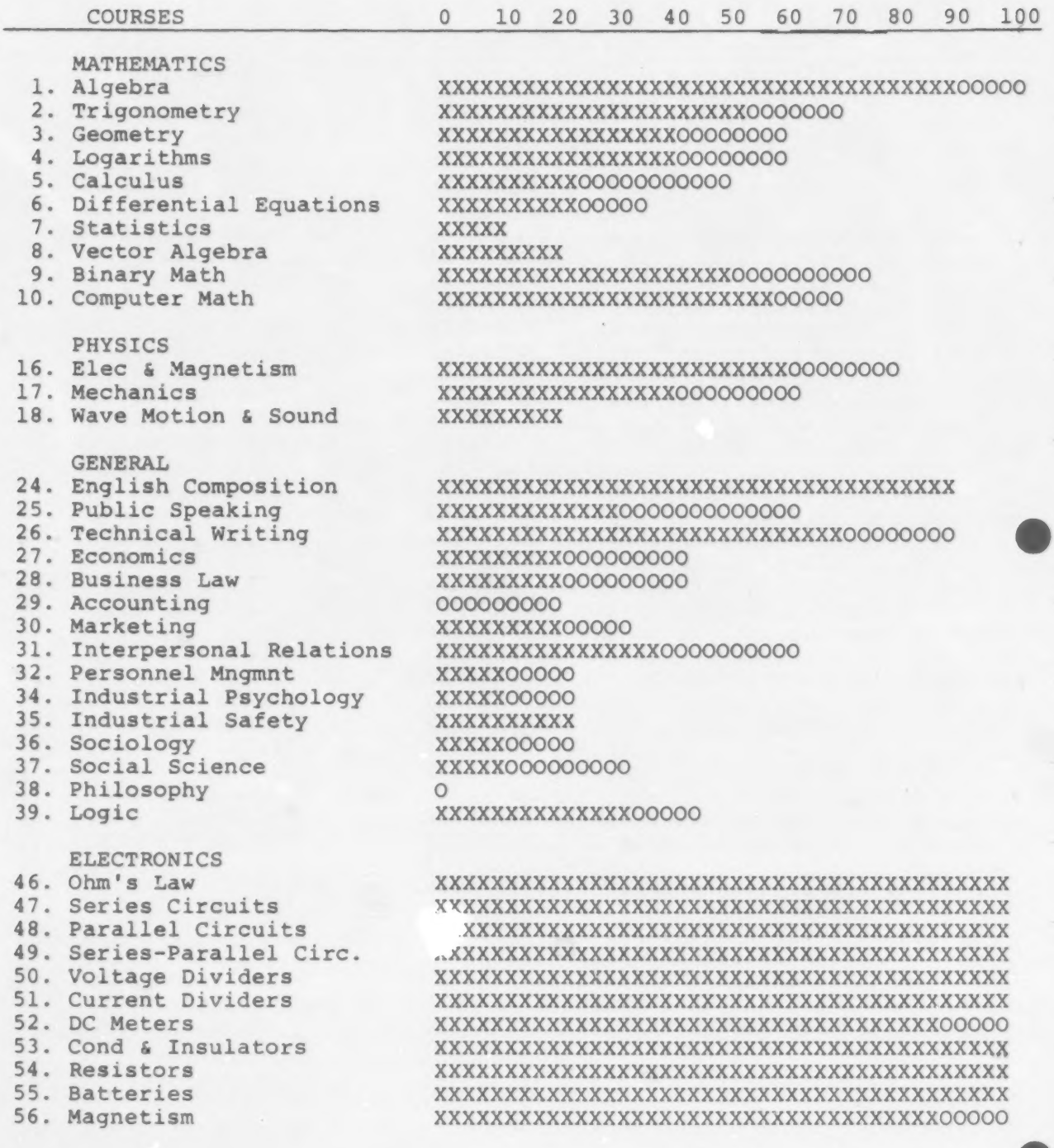

FIGURE 18. ELECTRONICS COMMUNICATIONS TECHNICIAN

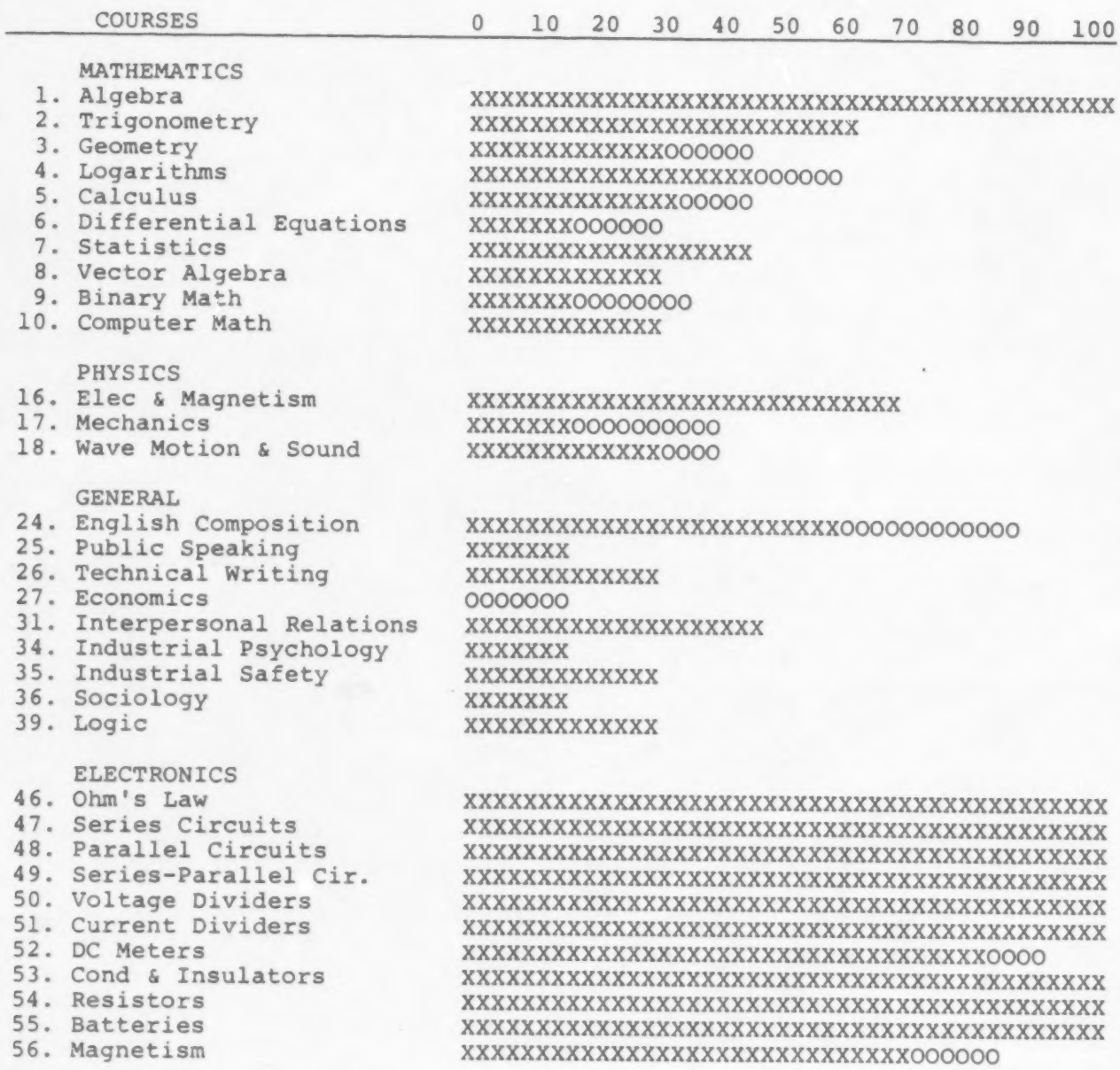

Fig. 18. cont. ELECTRONICS COMMUNICATIONS TECHNICIAN

COURSES	0 10 20 30 40 50 60 70 80 90 100
62. Superposition	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
63. Thevenin's Theorem	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
64. Norton's Theorem	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
65. Millman's Theorem	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
66. Kirchhoff's Current Law	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
67. Kirchhoff's Voltage Law	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
70. Reading Schematics	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
71. Using Hand Tools	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
72. Soldering Techniques	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
73. Use of Meters	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
74. Nontriggered Scopes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
75. Triggered Scopes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
76. Use of Bridges	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
79. AC Voltage & Current	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
80. Inductance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
81. Ind Reactance & Cir.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
82. Capacitance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
83. Cap Reactance & Cir.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
84. RC & L/R Time Constants	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
85. Impedance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
86. Power Factor	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
87. J Operator	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
88. Resonance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
89. Filters	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
95. Approximations	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
96. Semiconductor Theory	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
97. Diodes & Circuits	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
98. Bipolar Transistors	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
99. Transistor Biasing	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
100. AC Equivalent Cir.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
101. Small-Signal Amp.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
102. Class A Pwr. Amp.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
103. Class B Push-Pull	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
104. Class C Pwr. Amp.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
105. Field-Effect Trans	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
106. FET Cir. Analysis	XXXXXXXXXXXXXXXXXX
107. Decibels	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
108. Hybrid Parameters	XXXXXXXXXXXXXXXXXX

Fig. 18. cont. ELECTRONICS COMMUNICATIONS TECHNICIAN

COURSES	0 10 20 30 40 50 60 70 80 90 100
114. Frequency Effects	XXXXXXXXXXXXXXXXXXXXXXXX
115. Integrated Circuits	XXXXXXXXXXXXXXXXXXXXOOOOO
116. Neg Feedback OP AMPS	XXXXXXXXXXXXXXXXXXXXXXXX
117. Pos Feedback Osc.	XXXXXXXXXXXXXXXXXXXXXXXX
118. Voltage Regulation	XXXXXXXXXXXXXXXXXXOOOOOO
119. Op-Amp Applications	XXXXXXXXXXXXXXXXXX
120. Active Filters	XXXXXXXXXXXXXXXXXXXXXXXX
121. Frequency Domain	XXXXXXXXXXXXXXXXXXXXXXXX
122. Modulation	XXXXXXXXXXXXXXXXXXXXXXXX
123. Hybrid Parameters	XXXXXXXXXXXXXXXXXXOOOOOO
129. De Morgan's Theorem	XXXXXXXXXXXXXOOOOOO
130. Karnaugh Maps	XXXXXXXXXXXXX
131. TTL Digital IC's	XXXXXXXXXXXXXXXXXXXXXXXX
132. CMOS Digital IC's	XXXXXXXXXXXXXXXXXXXXXXXX
133. Boolean Algebra	XXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOO
134. Microprocessor Program	XXXXXXXXXXXXXXXXXXXXXXXX
135. Use of Assemblers	XXXXXXXXXXXXXXXXXX
136. LSI-II	XXXXXXXXXXXXXX
137. Semiconductor Memories	XXXXXXXXXXXXXXXXXXXXXXXX
138. Development Systems	XXXXXXXXXXXXXXXXXX
139. Microprocessor Interfac	XXXXXXXXXXXXXXXXXXXXXXXX
140. Logic Analyzers	XXXXXXXOOOOOO
141. Floppy Disk Drives	XXXXXXXXXXXXXXXXXX
142. 16 Bit Microprocessor	XXXXXXXXXXXXXXXXXX
143. Hard Disk Drivers	XXXXXXXXXXXXXOOOOOO
144. Display Systems	XXXXXXXXXXXXXXXXXX
145. U. V. Eraseable Proms	XXXXXXXXXXXXXXXXXX
151. Phase Locked Loops	XXXXXXXXXXXXXXXXXXXXXXXX
152. Power Control	XXXXXXXXXXXXXXXXXX
153. Data Communications	XXXXXXXXXXXXXXXXXXXXXXXX
154. RS-232 Standards	XXXXXXXXXXXXXXXXXXXXXXXX
155. IEEE-488 Bus Standard	XXXXXXXXXXXXXXXXXX
156. Intel Multibus or PBS	XXXXXXXXXXXXX
157. Modems	XXXXXXXXXXXXXOOOOOO
158. Printers	XXXXXXXXXXXXXOOOOOO
159. Fortran or Basic	XXXXXXXXXXXXXXXXXXOOOOOO

FIGURE 19. ELECTRONICS TECHNICAL WRITER

Fig. 19.cont. ELECTRONICS TECHNICAL WRITER

COURSES	0 10 20 30 40 50 60 70 80 90 100
62. Superposition	XXXXXXXXXXXXXXXXXXXXXXXXXXX
63. Thevenin's Theorem	XXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
64. Norton's Theorem	XXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
65. Millman's Theorem	XXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
66. Kirchhoff's Current Law	XXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
67. Kirchhoff's Voltage Law	XXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
70. Reading Schematics	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
71. Using Hand Tools	XXXXXXXXXXXXXXXXXXXXXXXXXX
72. Soldering Techniques	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
73. Use of Meters	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
74. Nontriggered Scopes	XXXXXXXXXXXXXXXXXXXXXXXXXX
75. Triggered Scopes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
76. Use of Bridges	XXXXXXXXXXXXXXXXXXXX
79. AC Voltage & Current	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
80. Inductance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
81. Ind Reactance & Cir.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
82. Capacitance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
83. Cap Reactance & Cir.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
84. RC & L/R Time Constants	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOO
85. Impedance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
86. Power Factor	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
87. J Operator	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
88. Resonance	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
89. Filters	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
95. Approximations	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
96. Semiconductor Theory	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
97. Diodes & Circuits	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
98. Bipolar Transistors	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
99. Transistor Biasing	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
100. AC Equiv Circuits	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOOOO
101. Small-Signal Amp.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOOOO
102. Class A Pwr. Amp.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOOOO
103. Class B Push-Pull	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
104. Class C Pwr. Amp.	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
105. Field-Effect Trans	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
106. FET Cir Analysis	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
107. Decibels	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOO
108. Hybrid Parameters	XXXX

Fig. 19.cont. ELECTRONICS TECHNICAL WRITER

COURSES	0 10 20 30 40 50 60 70 80 90 100
114. Frequency Effects	XXXXXXXXXXXXXXXXXOOOO
115. Integrated Circuits	XXXXXXXXXXXOOOOOOOOOOOOOOOOOO
116. Neg Feedback OP AMPS	XXXXXXXXXXXXXXXXXOOOOOOOOOOOOOOO
117. Pos Feedback Osc	XXXXXXXXXXXXXXXXXOOOOOOOOOOOOOOO
118. Voltage Regulation	XXXXXXXXXXXXXXXXXOOOOOOOOOOOOOOOOOO
119. Op-Amp Applications	XXXXXXXXXXXXOOOOOOOOOOOOO
120. Active Filters	XXXXXXXXXXXOOOO
121. Frequency Domain	XXXXXXXXXXX
122. Modulation	XXXXXXXXXXXXXXXX
123. Vacuum Tubes	XXXXXXXXXXX
129. De Morgan's Theorem	XXXXXXXXXXXXXXXX
130. Karnaugh Maps	XXXXXXXXXXXXXXXX
131. TTL Digital IC's	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
132. CMOS Digital IC's	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
133. Boolean Algebra	XXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
134. Microprocessor Program	XXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
135. Use of Assemblers	XXXXXXXXXXXXXXXXOOOOOOOOO
136. LSI-II	XXXXXXXXXXXOOOO
137. Semiconductor Memories	XXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOO
138. Development Systems	XXXXOOOO
139. Microprocessor Interfac	XXXXXXXXXXXOOOO
140. Logic Analyzers	XXXXOOOO
141. Floppy Disk Drives	OOOOOOOOOOO
142. 16 Bit Microprocessor	XXXXXOOOO
143. Hard Disk Driver	OOOOOOOOOOO
144. Display Systems	XXXXXOOOO
145. U. V. Eraseable Proms	XXXXXXXXXOOOO
151. Phase Lock Loops	OOOOO
152. Power Control	OOOOO
153. Data Communications	XXXXXXXXXXXXXOOOOOOOOOO
154. RS-232 Standards	XXXXXXXXXXXXXXXXXXXX
155. IEEE-488 Bus Stand	XXXXX
156. Intel Multibus	XXXXX
157. Modems	XXXXX
158. Printers	OOOOO
159. Fortran or Basic	XXXXXXXXXXXXXXXXXOOOOO

One company added Calibration Technician to the list. That information is contained in Figure 20 below:

FIGURE 20. ELECTRONICS CALIBRATION TECHNICIAN

ESSENTIAL COURSES	ADVISABLE COURSES
Algebra	Calculus
Trigonometry	Statistics
Geometry	Vector Algebra
Logarithms	Binary Math
Elec & Magnetism	Computer Math
Ohm's Law	Mechanics
Series Circuits	Wave Motion & Sound
Parallel Circuits	English Composition
Series-Parallel Circuits	Technical Writing
Voltage Dividers	Data Communications
Current Dividers	
DC Meters	
Conductor & Insulators	
Resistors	
Batteries	
Magnetism	
Superposition	
Thevenin's Theorem	
Kirchhoff's Current Law	
Kirchhoff's Voltage Law	
Reading Schematics	
Using Hand Tools	
Soldering Techniques	
Use of Meters	
Nontriggered Scopes	
Triggered Scopes	
Use of Bridges	
AC Voltage & Current	
Inductance	
Inductive Reactance & Circuits	
Capacitance	
Cap Reactance & Circuits	
RC & R/L Time Constants	
Impedance	
Power Factor	
J Operator	
Resonance	
Filters	

Fig. 20.cont. ELECTRONICS CALIBRATION TECHNICIAN

ESSENTIAL COURSES	ADVISABLE COURSES
Semiconductor Theory	
Diodes & Circuits	
Bipolar Transistors	
Transistor Biasing Circuits	
AC Equivalent Circuits	
Small-Signal Amplifiers	
Class A Power Amplifiers	
Class B Push-Pull Amplifiers	
Class C Power Amplifiers	
Field-Effect Transistors	
FET Circuit Analysis	
Decibels	
Frequency Effects	
Integrated Circuits	
Negative Feedback, OP AMPS	
Positive Feedback, Oscillators	
Voltage Regulation	
Op-Amp Applications	
Active Filters	
Frequency Domain	
Modulation	
Vacuum Tubes	
TTL Digital IC's	
CMOS Digital IC's	
Boolean Algebra	
Microprocessor Programming	
Semiconductor Memories	
Microprocessor Interfacing	
Logic Analyzers	
Floppy Disk Drives	
16 Bit Microprocessors	
Hard Disk Drivers	
Display Systems	
U. V. Eraseable Proms	
Phase Lock Loops	
Power Control (Scr. Triac)	
RS-232 Standards	
IEEE-488 Bus Standards	
Intel Multibus or Prolog Bus System	
Modems	
Printers	
Fortran or Basic	

As Figures 13 through 20 indicate, industry wants essentially the same basic instruction for all types of electronics technicians.

COMMENTS:

Algebra and trigonometry are definitely must courses with strong consideration being given to geometry. Logarithms can best be taught in electronic subjects.

Electricity and magnetism was highly recommended, but it is the view of the investigator (BS in Physics), that this course can cause confusion for the beginning student if it is taught in the Physics department.

English composition must be part of the curriculum, with technical writing strongly recommended.

Industry still feels that the "basics" are a must in the training of electronics technicians. These basics include the content of courses entitled: DC Electronics, AC Electronics, Introduction to Solid State, Introduction to Digital Electronics and their laboratories. Special attention should be given to manipulative skills such as using instruments, soldering and the use of hand tools.

Advanced courses must include a thorough study of analog, as well as digital devices. Vacuum tubes should be given only minute consideration.

CHAPTER VII

COMMENTS AND RECOMMENDATIONS

In this chapter, a recommended procedure will be given to the design of a two-year electronics curriculum. A sample general two-year electronics curriculum will be recommended as a model that may be added to or deleted from as appropriate. This model will be based upon the results from the survey.

Recommended Procedure

1. The electronics advisory committee can be most helpful in giving direction to the development of a curriculum that will meet local and regional needs.

2. Obtain an insight as to what industry expects from their electronics technicians by using the information from the advisory committee and the job descriptions in Chapter IV.

3. Study the curriculums of local colleges and of the colleges in Chapter III. The investigator was especially impressed with Foothill College. Here is a college in the middle of "Silicon Valley" that works closely with industry and has the pulse of the electronics field.

4. In Chapter V note the following:

   (a) In Figure 5, nearly three-fourths of the technicians are classified as Manufacturing, Production, Factory, Quality Assurance, Engineering, R & D or Design.

   (b) In Figure 6, two-thirds of the electronics technicians have two years of college or the Associates degree.

(c) The data in Figure 7, suggests that more companies have had experience with technicians from the community colleges and from other companies than with technicians from any other type of training program.

(d) As indicated by Figure 8, approximately two-thirds of the respondents indicated that they favored general technical training to specific technical training.

(e) In Figure 9, approximately sixty percent of the technicians acquired within the past two years came from community colleges and approximately twenty-three percent were experienced technicians from other companies.

(f) As indicated in Figure 12, forty percent of the electronics technicians needed in the next five years will be in the manufacturing, production or factory areas. These are probably the same type of areas with different companies using different titles for their technicians.

From the information above, we may conclude that the community college has been and will be the largest supplier of electronics technicians to industry. In designing an electronics curriculum that will meet the needs of the largest number of technicians, one should pay particular attention to the data in Figures 13, 15 and 16 as they include three-fourths of the type of electronics technicians needed in the next five years.

5. Using input from the advisory committee and the data from the technical training analysis in Chapter VI, design an electronics curriculum that will fit into your time frame. If that time frame is two years, it will be impossible to teach everything that industry feels is essential. The advisory committee can be used to narrow down the essential courses that should be taught.

Recommended Curriculum

The following curriculum is based upon the results of the technical training analysis survey and the programs of the colleges studied in Chapter III.

FIRST YEAR (Core) CURRICULA

(Required for all Electronic Students)

1st Quarter	2nd Quarter	3rd Quarter
Direct Current	Alternating Current	Intro to Solid State
Direct Current Lab	Alt Current Lab	Solid State Lab
Elex. Orientation	Network Theorems	Intro to Dig. Logic
Math	Math	Math

SECOND YEAR (General) CURRICULA

1st Quarter	2nd Quarter	3rd Quarter
Solid State Devices	Adv. Solid State Dev.	Special Circuits
Printed Circuits	Laboratory	Spc. Circuits Lab
Adv. Digital	Micro-Computers	Elex. Project
English Comp.	Technical Writing	Elex. Project Lab

Rather than requiring specific mathematics courses, three quarters of mathematics would be required; algebra, trigonometry and the other would be the student's choice. This allows the student with a math deficiency to get his basics and the good math student to take calculus, statistics or other advanced courses. English composition would be required. The student would be allowed to take either Technical Writing or another class in English Comp.

Course Descriptions

Direct Current Electronics: Five hours lecture

Ohm's Law
Series Circuits
Parallel Circuits
Series-Parallel Circuits
Voltage Dividers
Current Dividers
DC Meters
Conductors and Insulators
Resistors
Batteries
Magnetism

Direct Current Laboratory: Six hours laboratory

Laboratory experiments in all the above plus -
Reading Schematics
Using Hand Tools
Soldering Techniques
Use of VOM and DVM
Use of Bridges

Electronics Orientation: Two hours lecture

Speakers from industry to acquaint the student with the Electronics field.

Alternating Current Electronics: Five hours lecture

AC Voltage and Current
Inductance
Inductive Reactance and Circuits
Capacitance
Capacitive Reactance and Circuits
RC and L/R Time Constants
Impedance and LCR Circuits
Power Factor
Complex Numbers
Resonance
Filters

Alternating Current Laboratory: Six hours laboratory

Laboratory experiments in all the above plus -
Use of Triggered Scopes
Construction Practice
Troubleshooting Technique

Network Theorems: Four hours lecture

Superposition
Thevenin's Theorem
Norton's Theorem
Millman's Theorem
Kirchhoff's Current Law
Kirchhoff's Voltage Law

(The investigator feels that Network Theorems can best be taught in a separate course. It is normally taught in DC Electronics. This is a beginning class and the student can gain more from the theorems after he has had more circuit analysis).

Introduction to Solid State: Five hours lecture

Approximations
Semiconductor Theory
Diodes and Circuits
Bipolar Transistors
Transistor Biasing

Introduction to Solid State Lab: Six hours laboratory

Laboratory experiments in the lecture class.

Introduction to Digital Logic: Four hours lecture & lab

Digital Circuitry
Logic Gates
Counting Circuits
Special Circuit Design
Troubleshooting

Solid State Devices: Five hours lecture

AC Equivalent Circuits
Small-Signal Amplifiers
Class A Power Amplifiers
Class B Push-Pull Amplifiers
Class C Power Amplifiers

Printed Circuit Laboratory: Six hours laboratory

Developing Printed Circuit Boards
Construction of Solid State Amplifier
Approximation Technique

Advanced Digital Circuits: Five hours lecture

Introduction to Microcomputers
Counters
Registers
Memories
De Morgan's Theorem
TTL Digital IC's
CMOS Digital IC's
Boolean Algebra
Display Systems

Advanced Solid State Devices: Five hours lecture

Decibels
Integrated Circuits
Field-Effect Transistors
FET Circuit Analysis
Negative Feedback, Op-Amps
Positive Feedback, Osc.

Advanced Solid State Laboratory: Six hours laboratory

Active Filters Analysis and Troubleshooting
Phase Locked Loops
Solid State Power Control Circuits

Micro-Computers: Three hours lecture

Use of Assemblers
Semiconductor Memories
Development Systems
Microprocessor Interface
Logic Analyzers
Floppy Disk Drives
U. V. Eraseable Proms
Data Communications
RS-232 Standards
IEEE-488 Bus Standards

Special Circuits: Five hours lecture

Solid State Devices in Industry
Integrated Circuits in Industry
Active Filters
Voltage Regulation
Op-Amp Applications
Frequency Domain
Modulation
Phase Lock Loops
Power Control

Special Circuits Laboratory: Six hours laboratory

Analysis of Active Filters
Analysis of Phase Locked Loops
Analysis of Power Control Circuits
Troubleshooting

Electronics Project: Three hours lecture

Theory and application of electronics systems used in industry.

Electronics Project Laboratory:

Development and construction of an electronics system project chosen by the student.

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Prepared by the AEA Curriculum Task Force in cooperation with the Industrial Relations Committee

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Palo Alto, California

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AN AEA GUIDEBOOK

CURRICULUM REQUIREMENTS FOR ELECTRONIC TECHNICIAN TRAINING

November 1980

Prepared by the
AEA Curriculum Task Force
in cooperation with the
Industrial Relations Committee

Published by:
American Electronics Association

P.O. Box 11036
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INTRODUCTION

The community college is a primary resource for training and education of electronic technicians. Usually offering a one-year certificate or a two-year Associate of Arts degree in Electronics, the community college opens its doors to students from a variety of socio-economic backgrounds and skill levels. It is estimated that the de-emphasis on high school math requirements currently results in one-half to three-quarters of community college beginning electronics students lacking math skills through algebra--competencies necessary to adequately begin technical instruction. In addition, students, especially from the West and Southwest, come from diverse cultural backgrounds, compounding the challenge to teach a highly technical subject to many who use English as a second language. With often limited facilities and a shortage of instructors and up-to-date equipment, these two-year postsecondary schools provide a much-needed and often inadequately praised service to high-technology companies.

The curriculum information in this document has been generated at the request of both industry and the community colleges. It is intended to provide assistance and input to educators and industry trainers who wish to keep their programs state-of-the-art and to bring some standardization of curriculum to electronic technician education and training.

SUGGESTED USES OF CURRICULUM DOCUMENT

- o Industry members of education advisory committees can use the information to influence curriculum changes within college electronics and math departments.
- o Educators can use the information to update curriculum where necessary and help ensure responsiveness to industry needs.
- o Information can provide a base-line for start-up of new electronic technician training--within either education or industry.

AEA Curriculum Task Force Addresses Industry Concerns:

1. Quality of Education: Each community college has its own internal curriculu committee and multiple faculty perspectives through which curriculum changes must be negotiated. Sometimes curriculum status-quo is maintained because one or more faculty members have published electronics text-books which might be outdated by content changes. Other times curriculum is not modified simply because education hears industry speak with "many tongues" regarding unique needs of individual companies. Occasionally, curriculum remains the same because industry does not speak to education at all. Curriculum change, for a variety of reasons, therefore, comes slowly and often with great difficulty.

In fairness to educators, general agreement exists within and even amongst a majority of institutions about what should be taught as a "core" or basic two-year electronic technican curriculum. Yet industry continues to find gaps in basic fundamentals when hiring new graduates. One industry member of the AEA Curriculum Task Force voiced the frustrations of others when he complained that "fifty percent of the new electronic tech grads who apply for jobs at our company cannot operate an oscilloscope." Industry-at-large expresses concern over continuing gaps in graduates' abilities to make practical applications of theory, to troubleshoot, and use test equipment.

Task Force Goal:

To identify content topics which reflect state-of-the-art needs of industry and teaching objectives which will produce students who can make practical applications of theory, can troubleshoot, and use test equipment.

2. Shortages of Technicians: Electronics departments of community colleges and private schools operate autonomously from one another. Yet in our mobile society students often attend two or more educational institutions before completing their degree or certificate programs. Because of the lack of standardized curriculum amongst colleges, therefore, a student may be severely handicapped when trying to transfer units from one school to another. In some cases the college--unless its faculty is personally acquainted with the content of the student's former coursework--may even require the student to repeat classes. Such practices discourage students from the pursuit of formal education and contribute to the growing shortages of technical people.

Task Force Goal:

To develop a document reflecting an industry-wide (AEA) perspective of basic curriculum topics for electronic technician training to point educators and trainers towards a more standardized curriculum.

It is hoped that these materials will be a starting point for continuing dialog between industry and education to address both the quality and quantity issues in electronics technical training.

Pat Hill Hubbard, Manager
Technology Training and
Careers Program

Background:

In March 1980 a group of community college presidents and superintendents, electronics company presidents, members of the AEA San Francisco Council's Executive Committee and AEA Training Consortium met to address ways to remedy the shortages of technical people available for employment. At their direction, an AEA Curriculum Task Force was appointed with ten industry members. This Task Force was to identify content in four basic or "core" electronic technician courses--AC, DC, Digital, and Semiconductor--which reflects a state-of-art, industry-wide perspective.

Rick Moon of Rolm Corporation developed a "straw man" curriculum and members of the AEA Curriculum Task Force refined it over the next four months. In August, electronics faculty from Santa Clara Valley colleges were invited to give input, eventually forming a six-person combined industry-education group. Further material refinement occurred for another two months: Value and depth of emphasis scales for content topics in all four courses were developed and objectives were written for the AC and DC courses.

A five-member subcommittee of AEA's National Industrial Relations Committee (IR) was appointed to review the final materials. They commended highly the efforts of the AEA Curriculum Task Force and recommended IR Committee endorsement with the understanding that the depth scale ratings--which reflect the degree of emphasis industry wishes education to place on a given topic--be reviewed by companies in given locales and, where necessary, adjusted to meet local industry needs. The flexibility provided by adjusting the depth scale ratings makes the materials useful to companies and schools in all states.

The AEA IR Committee endorsed the materials in November, 1980.

CURRICULUM TASK FORCE: INDUSTRY MEMBERS

Geoff Bate	Verbatim Corporation
Lou Dominiczak	Acurex Corporation
Pat Hubbard	American Electronics Association
Tom Humphrey	American Microsystems, Inc.
Frank Logan	Signetics Corporation
Rick Moon	Rolm Corporation
Ken Mouw	Applied Technology, ITEK
Mary Ellen Porter	Applied Technology, ITEK
John Reeher	Finnigan Corporation
Ray Underwood	Chromatix, Inc.

CURRICULUM TASK FORCE: INDUSTRY-EDUCATOR SUBCOMMITTEE MEMBERS

Robert Kellejian	College of San Mateo
Frank Logan	Signetics Corporation
Rick Moon	Rolm Corporation
Robert Reininger	San Jose City College
Ray Underwood	Chromatix, Inc.
Ian Webb	West Valley Community College

AEA INDUSTRIAL RELATIONS SUBCOMMITTEE

Hall Acuff	Verbatim Corporation
John Galbraeth	Lockheed Missiles & Space Co.
Phil Lyons	Lockheed Missiles & Space Co.
Frank Matulis	Interstate Electronics Corporation
Doug Wendling	Signetics Corporation

American Electronics Association expresses appreciation for the time and effort spent by these people to produce these materials. A special recognition is made of the efforts of the six members of the Curriculum Task Force Industry-Educator Subcommittee.

State of California, Department of Education, Electricity/Electronics Curriculum Project

The AEA Curriculum Task Force wisnes to draw attention to the efforts of the State of California, Department of Education's Electricity/Electronics Curriculum Project, which has developed a competency-based electricity/electronics curriculum for grade levels 7 through 12. The purpose of this project is to:

- Assist local educational agencies by providing an articulated comprehensive and coordinated curriculum guide.
- Update present curriculum materials to meet industry needs.
- Maximize individual employability of students.
- Provide students with maximum success opportunity by increased awareness, exploration, and preparation for electricity/electronics careers.

More than 200 schools have received in-service on these materials to date and an uncountable number additionally at conventions and workshops. These curriculum materials and further information regarding this worthwhile project are available by writing:

Chris Almeida, Consultant-
Industrial Education
State Department of Education
Voc Ed Support Services Section
721 Capital Mall, 4th Floor
Sacramento, California 95814
(916) 445-8882

Keith Bush, Project Director
East Side Union High School Dist.
830 North Capitol Avenue
San Jose, California 95133
(408) 926-7500

The AEA Curriculum Task Force hopes information contained in this document proves helpful as the California State Curriculum Project develops curriculum for grades 13 and 14.

AEA CURRICULUM TASK FORCE RECOMMENDATIONS

- Because colleges lack equipment and are often three to five years behind state-of-the-art technology, courses should provide basics, with companies providing specifics for new employees.

- Every two-year electronic technician program should include a "transition" course to employment, where students apply classroom theory to practical simulations as defined by industry.

- Curriculum should be "compentency-based," focused on practical outcomes so that students are helped by instructors to convert fundamental concepts into practical applications.

- Ideally, students should be tested to ensure basic math skills through algebra before enrolling in a DC course. Present practice, however, is to allow students to simultaneously take a beginning math course and a DC course. This is done because 50-75% of the students lack basic math through algebra competency. To require a "make-up" math course one semester and thus force students to wait for a beginning electronics course the second semester is counter-productive: students will turn towards social science and liberal arts where they will not have to spend time in remediation courses.

  Given the poor math foundation of beginning students, therefore, the following options are strongly suggested:

  (1) Math should be integrated with electronics instruction in a synchronized, lockstep approach and taught as "Electronics Math" within the electronics department rather than the math department. This course would teach applied math rather than the present abstract-theoretical.

  (2) Math should be integrated with electronics within the same course and taught by the same teacher. This option faces opposition from math departments and credentialing requirements which generally require a masters degree in math--something few electronics instructors have.

  The best way to keep the curriculum up-to-date with industry's needs is for AEA to develop tests which students can take and be "certified," a future option to be discussed by the Association.

CONTENT RATING SCALES

To assist the classroom instructor to determine how much time and emphasis should be placed on each content topic, the following two rating scales were developed by the Task Force:

VALUE SCALE: 1---Must Know

2---Recommended to Know

3---Nice to Know If Time Permits

4---Unnecessary in This Course

DEPTH OF EMPHASIS SCALE:

1---Synthesize (Student should be able to relate circuit performance with variable; understand circuit relationship without mathematics; generalize.)

2---Analyze (Student should be able to compute without givens.)

3---Verbalize (Student can explain the concept orally or in writing.)

4---Recognize (Student should merely be aware of the concept.)

COURSE: DC ELECTRONICS	VALUE	DEPTH
UNIT 1: CURRENT		
1.1 Composition of Matter	2	3
1.2 Electrostatics	2	3
1.3 Current Flow	1	3
1.4 Electric Circuit	1	3
1.5 Measurements and Units	1	3

Student Should Be Able To:

- Define current and state units of measurement.
- Demonstrate understanding of fundamentals by explaining electron and current flows.
- Measure and calculate current in a circuit.
- Demonstrate ability to use an ammeter.

UNIT 2: VOLTAGE		
2.1 Electrical Force	1	3
2.2 Producing EMF	2	3
2.3 Batteries	2	3
2.4 Connecting Batteries	2	2
2.5 Concept of Ground	1	3
2.6 Measurements and Units	1	3

Student Should Be Able To:

- Demonstrate fundamentals behind sources of electricty; measure and calculate current in a circuit.
- Explain methods of producing EMF and state units of measurement; define voltage.
- Demonstrate and explain voltage drop in a circuit.
- Demonstrate understanding of concept of ground.
- Demonstrate ability to use voltmeter.

UNIT 3: RESISTANCE	VALUE	DEPTH
3.1 Basic Concepts	1	3
3.2 Resistors, Types, and Specs	1	3
3.3 Connecting Resistors	1	3
3.4 Resistance Measurements	1	3
3.5 Resistor Color Code	1	3

Student Should Be Able To:

- Define units of resistance
- Explain briefly why some materials are better conductors than others.
- Explain briefly types of resistors including: wire, carbon, metal, film, cermet.
- Measure and calculate resistance; use an ohmmeter.
- Identify resistors by marking and color codes.
- Distinguish between opens and shorts.

UNIT 4: SERIES CIRCUIT		
4.1 Basic Concepts of OHM'S Law	1	2
4.2 OHM's Law Applied--Simple Series Circuit	1	3
4.3 Resistances in Series	1	2
4.4 Power	1	2

Student Should Be Able To:

- Explain voltage sources in series, resistance in series.
- Reduce series circuits to most simple equivalent.
- Calculate and measure E, I, R in a series circuit.
- Use OHM's law to calculate the dependent variable.
- Demonstrate ability to determine whether circuit is operating as theory predicts.
- Demonstrate understanding of fundamentals of series circuit by troubleshooting one.

UNIT 5: PARALLEL CIRCUIT	VALUE	DEPTH
5.1 OHM's Law Applied--two parallel branches	1	2
5.2 OHM's Law Applied--three or more parallel branches	1	2
5.3 Series-Parallel Circuit-R Total	1	1
5.4 OHM's Law Applied--Series-Parallel Circuit	1	1

Student Should Be Able To:

- o Discuss current sources in parallel; resistors in parallel.
- o Calculate and measure E, I, R in a parallel circuit.
- o Demonstrate ability to use OHM's law in relation to parallel circuit.
- o Reduce parallel circuit to most simple equivalent.
- o Demonstrate understanding of fundamentals of parallel circuit by troubleshooting simple circuits, comparing theoretical calculations to measured parameters.

UNIT 6: DIVIDERS		
6.1 Voltage Dividers	1	1
6.2 Voltage Dividers Under Load	1	1
6.3 Current Divider	1	1

Student Should Be Able To:

- o Demonstrate understanding and uses of dividers, drawing on knowledge of series circuits, loading effects upon dividers from parallel circuit theory; troubleshoot a voltage and current divider.
- o Calculate and measure voltage drops.
- o Demonstrate applicability and use of OHM's law.

UNIT 7: MEASUREMENT OF CURRENT		
7.1 Basic Direct-Current Meter Movement	2	3
7.2 Ammeters	1	3
7.3 Extending Range of an Ammeter	2	2
7.4 Multirange Ammeter	2	2
7.5 Troubleshooting Techniques	1	1

Student Should Be Able To:

- o Demonstrate basic operation of analog and digital type meters.

UNIT 7: MEASUREMENT OF CURRENT (continued)

- Measure current in a series and parallel circuits.
- Measure current with analog and digital meters.
- Troubleshoot using an ammeter.
- Detect opens and shorts using an Ohmmeter.
- Demonstrate ability to use multimeters in troubleshooting series and parallel circuits.

UNIT 8: MEASUREMENT OF VOLTAGE

		VALUE	DEPTH
8.1	Voltmeters	1	2
8.2	Voltmeter Sensitivity	3	3
8.3	Loading Effects of a Voltmeter	1	2
8.4	Multirange Voltmeter	2	2
8.5	Troubleshooting Techniques	1	1

Student Should Be Able To:

- Draw circuit diagrams with voltmeter located to make measurements across whole circuit and its individual parts.
- Explain various types of voltmeters: analog, digital, VTVM, VOM, etc.
- Define typical voltmeter accuracies and explain which range of voltmeter scale (analog) provides most accurate reading.
- Explain how digital voltmeter accuracy is specified and compare it with analog voltmeter.
- Explain how, given maximum voltage on the scale and the basic meter movement current range, to make a voltmeter draw a circuit diagram without values for the metering circuit.
- Explain difference between 1,000 and 20,000 OHM per volt meter and why one is preferable to other in voltage measuring.
- Explain typical range of input resistance of fixed input resistance members and how to pick meter least likely to upset a circuit when making measurements.
- Explain how to measure voltages: reference to "ground," between two points "above ground" using an ungrounded meter, and between two points "above ground" using grounded meter.

UNIT 8: MEASUREMENT OF VOLTAGE (continued)	VALUE	DEPTH

- Troubleshoot circuits which contain open components using only a voltmeter to locate the open in the circuit.
- Troubleshoot circuits which contain a shorted component using only a voltmeter to locate the shorted component.

UNIT 9: MEASUREMENT OF RESISTANCE

9.1	Ohmmeters	1	2
9.2	Bridges	3	3
9.3	Multimeters	1	1
9.4	Troubleshooting Techniques	1	1

Student Should Be Able To:

- Demonstrate understanding of scale interpretation and range switch settings of typical analog type ohmmeters.
- Demonstrate understanding of differences in "probe to probe" voltages in ohmmeters used on different ranges.
- Explain how to construct simple ohmmeter with a meter movement, battery and resistance, explain why scale reads "backwards."
- Demonstrate what portion of an ohmmeter scale is most accurate and identify the typical accuracy of an ohmmeter.
- Explain why ohmmeter cannot be used on energized circuit.
- Explain why a bridge circuit would be used to make a resistance measurement.
- Draw a simplified circuit diagram, showing bridge circuit configuration employed in a typical bridge.
- Given a simple multi-meter, demonstrate correct use in each function, showing how to select correct range of each.
- Explain how ohmmeter can be used to locate: an open, a short, an out-of-value resistor in simple series/parallel resistance circuit.

UNIT 9: MEASUREMENT OF RESISTANCE (continued)	VALUE	DEPTH

- Explain how to determine whether a lead of an ohmmeter is positive or negative and when internal meter source may interfere with resistance reading.
- Measure resistance with analog and digital meters.

UNIT 10: POWER			
10.1	Definition	1	2
10.2	Calculation	1	1
10.3	Direct Measure	3	3
10.4	Transmission	2	2
10.5	Troubleshooting Techniques	1	1

Student Should Be Able To:

- Define power in terms of voltage and current and state "Watt's Law" in all forms.
- Calculate power dissipated or supplied given any two of the following: voltage, current resistance.
- Demonstrate awareness of the existence of wattmeters and how they can be used to measure power directly.
- Explain concept of "power match:" given a generatcr (source) and its internal resistance, specify load resistance for: maximum power transfer, maximum voltage transfer, and maximum current transfer.
- Explain how to make power measurements at the source and at all dissipative elements in a circuit and balance power consumed with power delivered.

UNIT 11: NETWORK ANALYSIS*			
11.1	Kirchhoff's First Law	1	1
11.2	Kirchhoff's Second Law	1	1
11.3	Conventions and Methods	3	3
11.4	Applications Using Kirchhoff's Law	3	3
11.5	Transformations	3	3
11.6	Superposition Theorem	3	3
11.7	Thevenin's Theorem	2	2
11.8	Norton's Theorem	3	3
11.9	Application of Thevenin's and Norton's Circuit	3	3

*Only one of the Network Analysis needs to be taught in depth, preferably Thevenin's Theorem.

Student Should Be Able To:

- State Kirchhoff's voltage and current law and use the laws to supply missing voltage or current given all but a missing voltage or current in a circuit.
- Explain process of assigning voltages and current in a circuit mesh and how to write simultaneous equations and solve them for all currents and voltages. Explain significance of negative value for current.
- Describe how a delta circuit can be converted to a wye and how opposite transformation can be made; show where in bridge circuit this transformation can be used to simplify circuit analysis. (Use textbook to find pertinent equations to perform delta to wye and wye to delta transformations.)
- State Superposition theorem and explain how it can be used to solve a simple example involving two loops, a common load and two battery sources.
- Explain Thevenin's Theorem and convert simple battery and resistance network circuits to an equivalent Thevenin configuration.
- State Norton's Theorem and draw simple circuit, demonstrating typical form of Norton source. Explain procedure for finding Norton Equivalent and how a Thevenin and Norton Equivalent are similar and different.
- Explain how a Norton or Thevenin circuit may be used as replacement for another circuit. Explain why it will simplify further analysis of circuit and use of a multiple number of loads requiring several calculations.

COURSE: AC ELECTRONICS	VALUE	DEPTH
UNIT 1: ALTERNATING CURRENT CONCEPTS		
1.1 Fundamental Concepts	1	2
1.2 Phasor Representation of Voltage & Current	1	1
1.3 AC Voltage Generation	2	2
1.4 Average Value of a Sine Wave	1	2
1.5 Effective Value of a Sine Wave	1	2
1.6 Nonsinusoidal Wave Forms	2	3
1.7 Phase Relationship in AC Circuits	1	1

Student Should Be Able To:

- Draw a sinusoid, explain difference between a sine and cosine, label horizontal axis in degrees and radians, and point out period of waveform.
- Calculate period, given frequency, and frequency given period.
- Calculate phase shift between two waveforms of same sinusoidal frequency.
- Relate representation of AC waveforms in terms of rotating vectors and show how amplitude/time drawing may be generated from phasor diagram.
- Understand concept of "phase difference" or phase shift, and relate it to phasor diagram and amplitude/time diagram.
- Explain why sinusoidal waveforms occur when turn of wire is rotating in a magnetic field.
- Understand concept of "average value" applied to AC waveform.
- Calculate average given peak value of a waveform.
- Calculate average given any value of AC waveform.
- Explain origination of RMS concept and outline how to calculate RMS from a drawing of AC waveform.
- Calculate RMS or effective given any other form of specifying AC amplitude.

UNIT 1: ALTERNATING CURRENT CONCEPTS (continued)	VALUE	DEPTH

- o Explain how to find RMS, average, peak, and peak-peak from square waves, positive and/or negative narrow pulses, sawtooths or other common waveforms.
- o Explain how AC meters might respond to non-sinusoidal voltages or currents at their inputs.
- o Explain concepts of phase relationship in AC circuits.
- o Define terms: phase lead, phase lag, in-phase, out of phase.

UNIT 2: EQUIPMENT AND MEASUREMENT FUNDAMENTALS

2.1	Oscilloscopes	1	1
2.2	Function/Signal Generator	1	2
2.3	Analog and Digital Meters	1	2
2.4	Measurement Techniques	1	1

Student Should Be Able To:

- o Explain how an oscilloscope works internally with attention to method of deflecting beam (deflection plates, sweep generator, etc.), produce a readable spot on tube face.
- o Describe types of waveforms that may be observed on an oscilloscope; know difference between AC and DC coupling; demonstrate how to attach oscilloscope leads for circuit measurements.
- o Explain how to use generators to power circuits.
- o Explain concept of internal resistance and its influence on use of generator.
- o Explain how grounded generator may be "isolated" and how grounded generator and scope can be used together.
- o Demonstrate how to recognize and make measurements on common types of function generator signals: sinusoid, sawtooth and square.
- o Demonstrate ability to use analog and digital meters of all types.

UNIT 2: EQUIPMENT AND MEASUREMENT FUNDAMENTALS (continued)	VALUE	DEPTH

- Given circuit diagram involving generators, loads, meters and oscilloscope, hook up given circuit and correctly make circuit measurements.
- Demonstrate ability to correctly measure waveforms with reference to ground and waveforms not referenced to ground, using: oscilloscope and analog or digital meters.
- Demonstrate ability to hook into circuits both grounded and isolated instruments, isolating instruments where required to produce desired circuit results.

UNIT 3: CAPACITANCE

3.1	Capacitance	1	2
3.2	Charge	1	2
3.3	Charge Storage	1	2
3.4	Charge-Discharge	1	2
3.5	Charge Units	1	3
3.6	Factors Affecting Capacitance	1	2
3.7	Capacitors in Series or Parallel	1	1
3.8	Capacitor Types	1	2
3.9	Capacitor Specifications	1	2
3.10	Measurement & Troubleshooting Techniques	1	2

Student Should Be Able To:

- Explain concept of capacitance, its construction, and factors that influence capacitance value.
- Demonstration relationship between charge, capacitance, and voltage, and capacitance units of measurement.
- Demonstrate understanding of units of charge and how capacitor stores charge.
- Sketch charge and discharge curves of voltage and current in circuit involving capacitors and resistors.
- Calculate time constant in RC circuit and equivalent capacitance in series, parallel, or series/parallel.
- Calculate charge distribution in capacitors when hooked in series and state voltage division between the capacitors.

UNIT 3: CAPACITANCE (continued)

		VALUE	DEPTH
o	Name 5 common capacitors dielectrics and explain why each might provide advantage when manufacturing a capacitor.		
o	Verbalize capacitance range of typical values for: ceramic capacitors, mylar capacitors, and electrolytic capacitors; suggest situations in which each capacitance might be used.		
o	Interpret ohmmeter reading when capacitor is measured and relate an unusual reading to possible capacitor failure.		
o	Make a measurement of a capacitor on a capacitance or LRC bridge.		
o	Given a circuit diagram, explain purpose of following capacitor usages: coupling, bypass, filtering. In transistor circuit, explain typical values of capacitors as specified.		

UNIT 4: INDUCTANCE

4.1	Induction	1	3
4.2	Inductance	1	2
4.3	Mutual Inductance	1	2
4.4	Inductances in Series or Parallel	1	1
4.5	Measurement and Troubleshooting Techniques	1	1

Student Should Be Able To:

- o Demonstrate ability to understand and apply fundamentals of inductors.
- o Discuss types of inductors.
- o Demonstrate applications of inductors.
- o Demonstrate measurement of inductors and ability to troubleshoot basic types.

UNIT 5: MAGNETISM AND TRANSFORMERS	VALUE	DEPTH
5.1 The Magnetic Field	3	3
5.2 Magnetic Units	3	3
5.3 Magnetization Curve & BH Looper	3	3
5.4 Magnetic & Electric Circuits Compared	3	3
5.5 Permeability & Shielding	2	3
5.6 Transformers	2	1
5.7 Autotransformers	1	1
5.8 Transformer Construction	3	3
5.9 Transformer & Induction Losses	2	3
5.10 Transformer Efficiency	2	2
5.11 Transformer Applications	1	1
5.12 Troubleshooting Techniques	1	1

Students Should Be Able To:

- Discuss applications of power transformers and autotransformers.
- Discuss series and parallel windings.
- Demonstrate understanding of generator fundamentals by troubleshooting one.
- Demonstrate understanding of motor fundamentals by troubleshooting one.
- Explain motor's operation, identification, and schematic symbol.
- Install a motor.
- Demonstrate effects of magnetic shielding.
- Demonstrate understarding of electromagnetics by troubleshooting an electromagnet.
- Demonstrate understanding of transformers by troubleshooting one.

UNIT 6: TIME CONSTANTS		
6.1 R Time Constants	3	3
6.2 RL Time Constants	1	1
6.3 Characteristics of the RL Circuit	1	1
6.4 RL Circuit Wave Forms	1	1
6.5 RC Time Constants	1	1
6.6 Characteristics of the RC Circuit	1	1
6.7 RC Circuit Waveforms	1	1
6.8 Universal Time Constant Curves	1	1
6.9 Step Functions and Square Waves	1	1
6.10 Short and Long Time Constants	1	1
6.11 Short and Long Time Constant Wave Forms	1	1

UNIT 6: TIME CONSTANTS (continued)

		VALUE	DEPTH
	Student Should Be Able To:		
o	Define an exponential function.		
o	Demonstrate understanding of fundamentals of RC and RL time constants by constructing RC and RL circuits and comparing results.		
o	Demonstrate understanding of fundamental characteristics of RC and RL Circuits by troubleshooting RC and RL circuits.		
o	Calculate time constants.		

UNIT 7: REACTANCE AND IMPEDANCE

7.1	Reactance	1	1
7.2	Inductive Reactance	1	1
7.3	Capacitive Reactance	1	1
7.4	Inductive Reactance in Series & Parallel	1	1
7.5	Capacitive Reactance in Series & Parallel	1	1
7.6	Impedance	1	1
7.7	Reactance Applications	1	1

Student Should Be Able To:

- o Define definitions of reactance and impedance.
- o Construct and compare operation of X_L and X_C circuits.
- o Calculate X_C and X_L and troubleshoot X_L and X_C circuits.
- o Explain characteristics of X_C and X_L circuits.
- o Demonstrate impedance matching and power loss and explain reasons for importance.
- o Reduce series and parallel circuits to simplest equivalent.

UNIT 8: AC SERIES CIRCUITS

8.1	Series Circuits Containing only R	3	3
8.2	Power in R Series Circuits	1	1
8.3	Series Circuits Containing only L	1	1
8.4	Power in L Series Circuits	2	3
8.5	Series Circuits Containing only C	1	1
8.6	Power in C Series Circuits	2	3
8.7	Series Circuits Containing R and L	1	1
8.8	Series Circuits Containing R and C	1	1
8.9	Series Circuits Containing R, L and C	1	1
8.10	Power in AC Series Circuits	1	1
8.11	Resonance in Series Circuit	1	1

Unit 8: AC Series Circuit (continued)

		VALUE	DEPTH

Student Should Be Able To:

- Demonstrate understanding of fundamentals of E, I, R in an AC series circuit.
- Construct series AC circuit and observe results when R, C frequency and L are changed.
- Demonstrate understanding of the relationship between "ELI" and "ICE".
- Demonstrate understanding of basic operation of a parallel circuit at resonance.
- Troubleshoot a parallel AC circuit.

UNIT 10: FILTERS

10.1	Electronic Circuit Characteristics	1	3
10.2	Circuits Containing both LAC and DC	1	3
10.3	Reference Levels	1	3
10.4	AC-DC Separation--Capacitive Coupling; Transformer Coupling, Bypassing	1	3
10.5	Filter Types: Low-pass; High-pass; Band-pass	1	3
10.6	Resonance Circuit Considerations	1	3
10.7	Resonant Filters	1	3
10.8	Filter Applications	1	3

Student Should Be Able To:

- Demonstrate understanding of each type of filter listed above and construct circuits with different filter types.
- Construct labs to show what happens with AC and DC in same circuit.
- Demonstrate understanding of importance of coupling and construct labs showing coupling.
- Construct labs to show isolation.
- Demonstrate understanding of filter applications by troubleshooting filter circuits.

COURSE: SEMICONDUCTOR ELECTRONICS		VALUE	DEPTH
UNIT 1: SEMICONDUCTOR FUNDAMENTALS			
1.1	Importance of Semiconductors	1	3
1.2	Semiconductor Materials	1	3
1.3	Germanium and Silicon Atoms and Crystal	1	3
1.4	Conduction in Intrinsic Germainum and Silicon	1	3
1.5	Conduction in Doped Germanium and Silicon	1	3
UNIT 2: SEMICONDUCTOR DIODES			
2.1	The PN Junction	1	1
2.2	Diode Biasing	1	1
2.3	Diode Characteristics	2	1
2.4	Diode Construction	2	3
2.5	Diode Applications	1	1
2.6	Testing PN Diodes	1	1
UNIT 3: THE ZENER DIODE			
3.1	Zener Diode Characteristics	2	1
3.2	Power Dissipation in Zener Diodes	2	1
3.3	Current Limitations in Zener Diodes	2	1
3.4	Voltage Regulation with Zener Diodes	2	1
3.5	Temperature Effects on Zener Diodes	2	1
3.6	Testing Zener Diodes	2	1
UNIT 4: SPECIAL APPLICATION DIODES			
4.1	Tunnel Diodes	4	4
4.2	Varactor Diode	2	3
4.3	High Frequency Diodes	3	3
4.4	Silicon Varistor	3	3
4.5	Testing of Special Application Diodes	4	4
UNIT 5: BIPOLAR TRANSISTOR			
5.1	PNP and NPN Configuration	1	1
5.2	Transistor Construction	2	3
5.3	Basic Transistor Action	1	1
5.4	Transistor Amplification	1	1
5.5	Transistor Characteristics	1	1
5.6	Maximum Transistor Ratings	I	2
5.7	Testing Bipolar Transistors	1	1
UNIT 6: BASIC BIPOLAR TRANSISTOR CIRCUITS			
6.1	Characteristics of Common-Base Circuits	1	2
6.2	Common-Emitter Circuits	1	2
6.3	Common-Collector Circuits	1	2

UNIT 7: FIELD-EFFECT TRANSISTORS (FETS)		VALUE	DEPTH
7.1	Basic FET Action	2	3
7.2	Enhancement Mode FETS	2	2
7.3	Depletion Mode FETS	2	2
7.4	FET Construction--Metal Gate	2	3
7.5	FET Construction--Silicon Gate	2	3
7.6	FET Amplification	1	1
7.7	FET Characteristics	1	1
7.8	Handling FETS	1	1
7.9	Testing FETS	1	1
UNIT 8: BASIC FET CIRCUITS			
8.1	Inverting Amplifier Stage (Common Source)	1	2
8.2	Non-inverting Amplifier Stage (Common Drain)	1	2
8.3	Constant Current Generator	1	2
8.4	Transmission Gate	2	2
8.5	Dynamic Logic (Storage Cells)	3	3
UNIT 9: THYRISTORS			
9.1	Silicon Controlled Rectifiers	2	3
9.2	TRIAC	2	3
9.3	Unijunction Transistors	3	3
9.4	Testing Thyristors	3	3
UNIT 10: OPTOELECTRONIC DEVICES			
10.1	Basic Principles of Light	3	3
10.2	Light Sensitive Devices	2	3
10.3	Light Emitting Devices	2	3
UNIT 11: BASIC BI-POLAR AND FET AMPLIFERS			
11.1	Importance of Amplifiers	3	3
11.2	Amplifier Circuit Configurations	2	1
11.3	Amplifier Biasing	2	1
11.4	Amplifier Coupling	1	1
11.5	Amplifer Gain and Characteristics	2	1
UNIT 12: TYPICAL BI-POLAR AND FET AMPLIFIERS			
12.1	Direct Current Amplifiers	2	3
12.2	Audio Amplifiers	2	3
12.3	Video Amplifiers	2	3
12.4	RF and IF Amplifiers	2	3
UNIT 13: OPERATIONAL AMPLIFIERS			
13.1	Differential Amplifiers	1	3
13.2	Operational Amplifier Characteristics	1	1
13.3	Closed-loop Operation (DC)	1	1
13.4	Applications of Operational Amplifiers	1	3
13.5	Testing of Operational Amplifiers	1	1

UNIT 14: OSCILLOSCOPE		VALUE	DEPTH
14.1	Oscillator Fundamentals	2	3
14.2	Transformer Oscillator	2	3
14.3	LC Oscillators	2	3
14.4	Crystal Controlled Oscillators	2	3
14.5	RC Oscillators	2	3
14.6	Non-Sinusoidal Oscillators	2	3
14.7	Higher Frequency Oscillators	3	3
UNIT 15:	PULSE CIRCUITS		
15.1	Non-Sinusoidal Waveforms	2	3
15.2	Wave Shaping	2	3
15.3	Rectangular Wave Generators	2	3
15.4	Ramp Generators	2	3
UNIT 16:	POWER SUPPLIES		
16.1	Rectifier Circuits	2	3
16.2	Power Supply Filter Circuits	2	3
16.3	Voltage Multipliers	2	3
16.4	Voltage Regulation	2	3
16.5	Current Regulation	2	3
16.6	Power Supply Circuits	2	3
16.7	Switching Power Supplies	2	3
16.8	Troubleshooting Power Supplies	2	3

COURSE: DIGITAL ELECTRONICS		VALUE	DEPTH
UNIT 1: DIGITAL BASICS			
1.1	Boolean Algebra	1	1
1.2	Logic Functions, Gates, Symbols and Truth Tables	1	2
1.3	Logic Families:		
	A. T-T-L and Sub-Families	1	2
	B. ECL	3	3
	C. MOS	2	3
	D. C-MOS	1	2
	E. I^2L	3	3
1.4	Buffers, Drivers, and Level Detectors	1	2
UNIT 2: FLIP FLOPS			
2.1	RS Flip-Flops	1	2
2.2	RST Flip-Flops	1	2
2.3	JK	1	2
2.4	Master-Slave	1	2
2.5	D	1	2
2.6	T	1	2
2.7	One Shot Multivibrators and Timers	1	2
UNIT 3: COUNTERS			
3.1	Inputs and Outputs	1	2
	A. Binary Asynchronous	1	2
	B. Decade	1	2
	C. Up/Down	1	2
	D. Divide by N	1	2
	E. Synchronous and Asynchronous Configurations	1	2
UNIT 4: SHIFT REGISTERS			
4.1	Applications: Parallel to Serial Converters	1	2
4.2	Applications: Serial to Parallel Converters	1	2
UNIT 5: DECODERS AND ENCODERS			
5.1	Decoders	1	2
5.2	Encoders	1	2
UNIT 6: MULTIPLEXERS			
6.1	Multiplexers	1	2
6.2	Data Selectors	1	2
6.3	Multiple Data Input	1	2
UNIT 7: DISPLAYS			
7.1	LED	1	2
7.2	Seven Segment Displays	1	2
7.3	Multiplexed Displays	1	2
7.4	LCD	1	2
7.5	Gaseous	1	2

UNIT 8: MEMORY DEVICES		VALUE	DEPTH
8.1	Semiconductor RAM	1	2
8.2	Semiconductor ROM	1	2
8.3	Magnetic Memories	3	3
UNIT 9: PROGRAMMABLE LOGIC DEVICES			
9.1	Logic Array (PLA/FPLA, Etc.)	1	3
9.2	ROM	1	2
UNIT 10: DIGITAL TROUBLESHOOTING			
10.1	Logic, Block, and Connection Diagrams	1	2
10.2	Circuit Tracing	1	2
10.3	Synchronizing Signals	1	2
10.4	Timing Charts	1	2

Gregg Division

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1221 Avenue of the Americas
New York, New York 10020
Telephone 212/997-

March 2, 1981

Dr. Richard Falley
Olympic Community College
Bremerton, WA 98310

Dear Dr. Falley:

With reference to our recent phone conversation I have listed what I consider strong electronics technology programs around the country. Unfortunately it is impossible to keep constant track of these programs. Quality and direction are subject to change due to staff changes, administration, funding, etc.

With that caveat here is the list (with apologies to all those great schools that I failed to mention):

Foothill College, California
College of San Mateo, California
Queensborough Community College, N.Y.C.
Wentworth Institute, Boston
Ohio Institute of Technology, Columbus
Utah Technical College, Provo
Milwaukee Area Technical College
Macomb County C.C., Warren, Mich.
Franklin Institute of Boston
Louisiana Vocational and Technical Institute, Shreveport
Catawba Valley Technical Institute, Hickory, N.C.
New York Institute of Technology
Tampa Technical Institute, Florida
Florissant Valley, C.C. Ferguson, Missouri
Portland Community College, Oregon

Some of these schools also have four-year programs but are included because of a strong two-year curriculum.

We hope this list will be of some help in your study.

Best personal regards.

Sincerely,

Gordon Rockmaker
Editor-In-Chief
Electricity/Electronics

/mv

Dear Sir:

Olympic College is endeavoring to identify the electronic technological needs of industry in order to update the electronic curriculum. Your company's needs represent an important part of the total electronic technological concern of industry. Therefore, we consider receiving a response from you to be a valuable contribution to this study.

To fulfill the needs of industry and render an educational service to young people, it is essential to pinpoint the specific areas of greatest need. We are trying to determine not only the number of technicians needed by industry but also the specific types of electronic technicians and talents he is expected to possess.

To answer this questionnaire will take about one hour of your time. Where the responses require technical insight and knowledge, we would appreciate it if you would consult a functioning technician. Ultimately we hope this will involve a curriculum that will provide you as an employer with more and better qualified electronic technical personnel.

Permit me to thank you for your time and attention given to this questionnaire.

Sincerely yours,

Richard W. Falley
Principal Investigator
Electronics Department

Darrell Estep
Project Director
Division Chairman of the
Division of Business and
Engineering Related
Occupations

SURVEY OF THE
ELECTRONIC TECHNICAL NEEDS OF INDUSTRY

Note: Where actual records are not available, please estimate the answer to the question.

1. Please list the industrial classifications that are of primary and major concern to your company locally (such as avionics, communications, medical electronics, etc.)

_____

_____

_____

_____

2. What is the basic organization of your company?
(Check one)

1. _____ local
2. _____ regional (several states)
3. _____ national (all states)
4. _____ international

3. What was the approximate gross dollar value of your industrial product during the past business year in your local plant?
(Check one)

1. _____ $0 - 200,000
2. _____ 200,000 - 500,000
3. _____ 500,000 - 1 million
4. _____ 1 million - 2 million
5. _____ 2 million - 5 million
6. _____ 5 million - 10 million
7. _____ 10 million - 20 million
8. _____ 20 million - 50 million
9. _____ 50 million and over

4. What is the total number of people employed by your company locally?

1. 1978 _____
2. 1979 _____
3. 1980 _____
4. 1981 _____ (estimated)

5. What is the total number of electronic technicians employed by your company locally?

   1. 1978 _____
   2. 1979 _____
   3. 1980 _____
   4. 1981 _____

6. What is the total number of electronic technicians classified as manufacturing, production or factory technicians employed by your company locally?

   1. 1978 _____
   2. 1979 _____
   3. 1980 _____
   4. 1981 _____

7. What is the total number of electronic technicians classified as Automatic Test Equipment Operators employed by your company locally?

   1. 1978 _____
   2. 1979 _____
   3. 1980 _____
   4. 1981 _____

8. What is the total number of electronic technicians classified as Quality Assurance technicians employed by your company locally?

   1. 1978 _____
   2. 1979 _____
   3. 1980 _____
   4. 1981 _____

9. What is the total number of electronic technicians classified as engineering, design or R & D technicians employed by your company locally?

   1. 1978 _____
   2. 1979 _____
   3. 1980 _____
   4. 1981 _____

10. What is the total number of electronic technicians classified as customer service or field service technicians employed by your company locally?

    1. 1978 _____
    2. 1979 _____
    3. 1980 _____
    4. 1981 _____

11. What is the total number of electronic technicians classified as communications technicians employed by your company locally?

    1. 1978 _____
    2. 1979 _____
    3. 1980 _____
    4. 1981 _____

12. What is the total number of electronic technicians classified as technical writers employed by your company locally?

1. 1978 _____
2. 1979 _____
3. 1980 _____
4. 1981 _____

If you have any electronic technicians that do not fall in the classifications listed in numbers 8 through 11, please write in the classifications in 13 through 15 and answer as before.

13. What is the total number of electronic technicians classified as

_____
employed by your company locally?

1. 1978 _____
2. 1979 _____
3. 1980 _____
4. 1981 _____

14. What is the total number of electronic technicians classified as

_____
employed by your company locally?

1. 1978 _____
2. 1979 _____
3. 1980 _____
4. 1981 _____

15. What is the total number of electronic technicians classified as

_____
employed by your company locally?

1. 1978 _____
2. 1979 _____
3. 1980 _____
4. 1981 _____

16. For this year (1981) what is the number of electronic technicians employed by your local company having the following educational background?

(No. of technicians)	(Educational background)
1. _____	less than high school graduation
2. _____	high school graduation
3. _____	military experience
4. _____	1 year of college
5. _____	2 years of college or Associate's degree
6. _____	4 years of college or Bachelor's degree
7. _____	education beyond the Bachelor's degree

17. Rank the top four electronic technician programs in order of preference (1, best--4, poorest) which your company feels provides the most satisfactory electronic technicians.

(Rank 1 to 4)	(Technical programs)
1. _____	Technical high school
2. _____	two year private tech. schools
3. _____	two year public tech. schools
4. _____	two year community colleges
5. _____	four year technical trainee programs
6. _____	experienced technicians from other companies
7. _____	your own in-service program
8. _____	other explain _____

_____

_____

18. What is your preference locally, with regard to background training, when hiring electronic technicians? (Check one)

	(Background training)
1. _____	general technical training
2. _____	specific technical training

Comments _____

_____

_____

19. How many technicians have you acquired within the past two years from the following sources?

(Number)	(Sources)
1. _____	two year private tech. schools
2. _____	two year public tech. schools
3. _____	community colleges
4. _____	high schools
5. _____	four year colleges and universities
6. _____	experienced technicians from other companies
7. _____	upgrade from your production areas
8. _____	other, explain _____

_____

_____

20. Do you have an in-plant training program exclusively for your electronic technicians?

Yes _____ No _____

If yes, how many have you trained in the last 2 years? (Number) _____
If yes, briefly describe this program _____

_____

_____

21. Do you have an in-service training program for your electronic technicians where you use the facilities of neighboring educational institutions?

Yes _____ No _____

If yes, approximately how many of your employees were involved in this training in the past two years?

(Number) _____

22. Approximately how many additional electronic technicians in the areas indicated below will your company need in 5 years (by 1985)?

(How many?)	(Areas)
1. _____	Manufacturing, production or factory
2. _____	Test equipment operator
3. _____	Quality Assurance
4. _____	Engineering, design or R & D
5. _____	Customer service or field service
6. _____	Communications
7. _____	Technical writer
8. _____	_____
9. _____	_____
10. _____	_____

On this page and the following pages we ask you to check those courses which you feel are essential or advisable preparation for the technicians found in your company. In responding use symbols X for Essential, O for Advisable, and leave blank if not necessary. If the Listing does not include technicians employed by your company or courses felt desirable, please write them in at the end of the appropriate list and complete the form as previously requested.

If you do not feel qualified to make judgments regarding necessary courses, please seek the assistance of someone in your organization whose background enables him to make these necessary judgments.

SYMBOLS: X - ESSENTIAL
O - ADVISABLE
(Leave Blank if Not Necessary)

	Mfg., Production & Factory Tech.	Automatic Test Equipment Operator	Quality Assurance Tech.	Engr., Design or R & D Tech.	Customer Service & Field Service Tech.	Communications Tech.	Technical Writer			
MATHEMATICS COURSES										
1. Algebra										
2. Trigonometry										
3. Geometry										
4. Logarithms										
5. Calculus										
6. Differential Equations										
7. Statistics										
8. Vector Algebra										
9. Binary Math										
10. Computer Math										
11.										
12.										
13.										
14.										
15.										
PHYSICS COURSES										
16. Elec. & Magnetism										
17. Mechanics										
18. Wave Motion & Sound										
19.										
20.										
21.										
22.										
23.										

GENERAL COURSES	Mfg., Production & Factory Tech.	Automatic Test Equipment Operator	Quality Assurance Tech.	Engr., Design or R & D Tech.	Customer Service & Field Service Tech.	Communications Tech.	Technical Writer				
24. English Composition											
25. Public Speaking											
26. Technical Writing											
27. Economics											
28. Business Law											
29. Accounting											
30. Marketing											
31. Interpersonal Relations											
32. Personnel Management											
33. Plant Design											
34. Industrial Psychology											
35. Industrial Safety											
36. Sociology											
37. Social Science											
38. Philosophy											
39. Logic											
40.											
41.											
42.											
43.											
44.											
45.											
ELECTRONIC SUBJECTS											
46. Ohm's Law											
47. Series Circuits											
48. Parallel Circuits											
49. Series-Parallel Circuits											
50. Voltage Dividers											
51. Current Dividers											
52. DC Meters											
53. Conductors & Insulators											
54. Resistors											
55. Batteries											
56. Magnetism											
57.											
58.											
59.											
60.											
61.											

ELECTRONIC SUBJECTS	Mfg., Production & Factory Tech.	Automatic Test Equipment Operator	Quality Assurance Tech.	Engr., Design or R & D Tech.	Customer Service & Field Service Tech.	Communications Tech.	Technical Writer				
62. Superposition											
63. Thevenin's Theorem											
64. Norton's Theorem											
65. Millman's Theorem											
66. Kirchhoff's Current Law											
67. Kirchhoff's Voltage Law											
68.											
69.											
70. Reading Schematics											
71. Using Hand Tools											
72. Soldering Techniques											
73. Use of Meters (VOM) (DVOM)											
74. Nontriggered Scopes											
75. Triggered Scopes											
76. Use of Bridges											
77.											
78.											
79. AC Voltage & Current											
80. Inductance											
81. Inductive Reactance & Circuits											
82. Capacitance											
83. Cap Reactance & Circuits											
84. RC & L/R Time Constants											
85. Impedance											
86. Power Factor											
87. J Operator											
88. Resonance											
89. Filters											
90.											
91.											
92.											
93.											
94.											
95. Approximations											
96. Semiconductor Theory											
97. Diodes & Circuits											
98. Bipolar Transistors											
99. Transistor Biasing Circuits											
100. AC Equivalent Circuits											

ELECTRONIC SUBJECTS	Mfg., Production & Factory Tech.	Automatic Test Equipment Operator	Quality Assurance Tech.	Engr., Design or R & D Tech.	Customer Service & Field Service Tech.	Communications Tech.	Technical Writer				
I01. Small-Signal Amplifiers											
I02. Class A Power Amplifiers											
I03. Class B Push-Pull Amplifiers											
I04. Class C Power Amplifiers											
I05. Field-Effect Transistors											
I06. FET Circuit Analysis (JFET MOSFETS)											
I07. Decibels											
I08. Hybrid Parameters											
I09.											
I10.											
I11.											
I12.											
I13.											
I14. Frequency Effects											
I15. Integrated Circuits											
I16. Negative Feedback, OP AMPS											
I17. Positive Feedback, Oscillators											
I18. Voltage Regulation											
I19. Op-Amp Applications											
I20. Active Filters											
I21. Frequency Domain											
I22. Modulation											
I23. Vacuum Tubes											
I24.											
I25.											
I26.											
I27.											
I28.											
I29. De Morgan's Theorem											
I30. Karnaugh Maps											
I31. TTL Digital IC's											
I32. CMOS Digital ICS											
I33. Boolean Algebra											
I34. Microprocessor Programming											
I35. Use of Assemblers											
I36. LSI-11											
I37. Semiconductor Memories											
I38. Development Systems											
I39. Microprocessor Interfacing											
I40. Logic Analyzers											

ELECTRONIC SUBJECTS	Mfg., Production & Factory Tech.	Automatic Test Equipment Operator	Quality Assurance Tech.	Engr., Design or R & D Tech.	Customer Service & Field Service Tech.	Communications Tech.	Technical Writer			
I41. Floppy Disk Drives										
I42. 16 Bit Microprocessors										
I43. Hard Disk Drivers										
I44. Display Systems										
I45. U.V. Eraseable Proms										
I46.										
I47.										
I48.										
I49.										
I50.										
I51. Phase Locked Loops										
I52. Power Control (Scr. Triac)										
I53. Data Communications										
I54. RS-232 Standards										
I55. IEEE-488 Bus Standards										
I56. Intel Multibus or Prolog Bus System										
I57. Modems										
I58. Printers										
I59. Fortran or Basic										
I60.										
I61.										
I62.										
I63.										
I64.										